This thesis is submitted for the degree of Doctor of Philosophy in Development Studies

Essays on Global Imbalances and the Financial Crisis

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December 2019

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Declaration

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Abstract

This thesis investigates the linkages and the underlying causes of the current episode of global imbalances and of the 2007-09 Global Financial Crisis (GFC). It consists of three independent yet interconnected essays. The first essay is a theoretical paper. It sets the scene for the theoretical debates by first describing how the GFC unfolded, its economic consequences, the causes that are identified. It is followed by a critical assessment of three competing theories to explain the linkages between the global imbalances and the GFC: the global savings glut (GSG) hypothesis, the endogenous money (EM) and the global financing glut (GFG) hypotheses. The second essay is an empirical paper, which seeks evidence for each underlying logic chain behind the three theories. It has a particular focus on how credit creation and international capital flows impact on the US housing boom, credit boom, and consequently the consumption boom, before the GFC. A partial equilibrium model is built to simulate the propagation mechanisms based on the empirical findings. The third essay is a modelling chapter. It begins with a discussion of the development of macroeconomic models in general. Following Wynne Godley's stock-flow consistent (SFC) modelling approach, the focus of this essay is to build a fully estimated empirical SFC model for the UK. The model features detailed financial balance sheets for the banking sector, which can be used to simulate the endogenous credit creation process and the interactions between the real and the financial sector within an economy. The simulations focus on the role of housing finance in generating the economic expansions and contractions as discussed in the second paper.

To my beloved grandparents, my first teachers

Yixian Shan and Shukai Xia

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Acknowledgments

First and foremost, I would like to express the most profound appreciation to my supervisor Dr Ken Coutts and adviser Dr Graham Gudgin for their invaluable guidance, comments, and engagement in this PhD research over the past four years. Without their support, this thesis would not have been possible. Our regular Wednesday meetings have become an indispensable part of my Cambridge experience – one that I will never forget. Our countless thought-provoking conversations have made me a better economist than I ever imagined.

I want to take the opportunity to thank Wynne Godley, an economist I have never met. I thank him for his contributions in the field of stock-flow consistent modelling. Without him planting the seeds, I would probably not have come to Cambridge for my PhD study and never had the opportunity to work so closely with Ken and Graham. I am delighted to witness his line of research flourishing in recent years.

I also extend my gratitude to Professor Gennaro Zezza and Michael Kuczynski for their valuable comments, Professor Marc Lavoie and Professor Philip Arestis for sharing their most recent work on endogenous money creation and Post-Keynesian economics, Professor Neil Gibson and Jordan Buchanan for their assistance on the CBR UK model, Dr Cam Bowie for his meticulous work on the UK balance sheet and the transaction flows data, Professor Rui Esteves for pointing me in the right direction among the vast ocean of economic history literature, John Marshall for his excellent help in proofreading the thesis and Shaoran Li for the timely discussion and suggestions on time-series econometrics.

Furthermore, I also owe a debt of gratitude to Sidney Sussex College and the Centre of Development Studies for hosting me and being so supportive in pursuing this piece of research. I have come across so many interesting souls in Cambridge and I'm fortunate enough to become friends with many of them. It is a place that inspires and drives me to become a researcher that seeks the truth rather than what is commonly accepted. It is also the place where I met my wonderful fiancée,

Xiao Wang, who has made this PhD journey even more complete and meaningful. The love and happiness that we share continually encourage me to become a better version of myself.

Last but not least, I would like to thank my beloved family. As study and research have become an indispensable part of my life, they have taken a heavy toll on other aspects of my life, such as family time. This year marks my thirteenth year away from home. My parents, Manjun Lu and Zhiliang Xia, are the perfect parents one could ever ask for – they are open-minded, supportive, and understanding. Their endless love has been my greatest console throughout my extensive academic study abroad.

1. Introduction

Many economists agree that the 2007 – 2009 Global Financial Crisis (GFC) was the worst crisis since the Great Depression. More than a decade later, its effects are still clearly evident. In the years since the crisis, research on its origins has developed from numerous directions. It is generally accepted that the initial trigger of the crisis was the bursting of the US housing bubble in 2007 due to relaxed credit standards in mortgage lending. However, economists hold different views on the underlying causes of the crisis, especially regarding the relative importance of different contributory factors. While issues such as ineffective financial regulation and low policy rates set by the US Federal Reserve after the dotcom crash of 2000 are widely seen to have contributed, the story of the origins of the GFC cannot be adequately understood without consideration of another key contributory factor – the accumulation of global imbalances.

The primary purpose of this thesis is to investigate the linkages and the underlying causes of the current episode of global imbalances and the 2007- 2009 GFC. Current account imbalances, often referred to as global imbalances, have been at the centre of policy debates for a long time. These imbalances have gradually built up since the late 1990s. Some countries, such as the US and the UK, have traditionally experienced long-term current account deficits, while other economies, such as China, other emerging Asian countries and many major oil exporters, have run persistent current account surpluses. As a result of this large foreign reserves have been accumulated, which have subsequently been invested in dollar-denominated assets. The dominant theory behind the global imbalances phenomenon is known as the Global Savings Glut (GSG) hypothesis. This hypothesis argues that excessive global savings in trade-surplus countries lowered global long-term interest rates, which in turn eased access to credit and facilitated consumption booms and housing bubbles in the run-up to 2007. Growing domestic expenditure in deficit countries then led to higher demand for imports from surplus countries, with the surpluses generated as

a result being channelled back to the deficit countries. As the cycle continued, the imbalances grew larger (see Bernanke (2009) and Krugman (2009)).

This thesis consists of three independent yet interconnected essays. The focal point of the first essay (Chapter 2) is the theoretical validity of the GSG hypothesis in explaining the GFC. Within this chapter, Section 2.2 describes the major events during the GFC between 2007 and 2009. It also presents a literature review on the economic consequences and the causes of the GFC. A critical assessment of the linkage between the GSG hypothesis and GFC is set out in Section 2.3. In particular, this section explores in detail the theoretical ties between GSG and the GFC. However, as the section will reveal, a review of the consequences of various episodes of global imbalances in the economic history literature finds mixed evidence for the relationship between global imbalances and financial crises. Section 2.4 shifts the focus to two alternative theories, the Endogenous Money (EM) and the Global Financing Glut (GFG) hypotheses and considers whether these may address the theoretical weakness[1] of the GSG hypothesis.

Combining appropriate theory with empirical observations[2] can provide critical insights as far as predicting future events is concerned. For example, for advocates of neo-classical economics, events such as the 2007 – 2009 financial crisis are purely exogenous, causing only short-run deviations from the long-run trend. Money and banking are neutral to the economic equilibrium, which is determined by real factors[3], at least in the long-run. The proponents of Minsky's Financial Instability Hypothesis (FIH), however, would argue that the GFC was endogenous to the modern capitalist economy, considering the important role of the banking sector in the endogenous money (EM) creation process. According to Minsky (1993), it is useful to model the capitalist economy using a set of interrelated balance sheets, which has substantial implications for empirical analysis in macroeconomics.

Therefore, following the theoretical analysis in the first essay, the second essay (Chapter 3) aims to provide a thorough empirical investigation of the internal logic

[1]For example, the framework that underpins the GSG hypothesis essentially relies on the pre-Keynesian saving-investment balance via natural rate of interest. Money and credit play a central role in the GFG and EM hypotheses, whereas they have no role in the GSG story.

[2]In the field of science, in order to prove or disprove a hypothesis or theory, one can either use logical reasoning or empirical evidence.

[3]New Keynesians rely on market imperfections and friction to generate non-neutrality results (Minsky, 1993). See Chapter 4 for a more detailed discussion on the methodology of macroeconomic modelling.

chains of the three competing theories discussed in the first essay using US data[4]. The investigation aims to answer four specific research questions:

1. What role did access to credit and housing prices play in determining US domestic consumption? (See sec. 3.3)
2. What were the key drivers of the US credit and housing boom before the crisis? (See sec. 3.4)
3. Was the GSG (trans-Pacific capital flows) the primary cause of the 2007– 2009 financial crisis, or was the GFG (trans-Atlantic capital flows) the primary factor? (See sec. 3.5)
4. Did international capital flows lower US long-term interest rates? (See sec. 3.5)

International capital flows and domestic credit conditions are the most critical explanatory variables in order to prove or disprove the three theories. While the GSG hypothesis focuses on trans-Pacific capital flows into the US before the financial crisis, the GFG story stresses the importance of trans-Atlantic capital flows. The domestic credit conditions are thus useful for examining the validity of the EM hypothesis. Other explanatory variables are selected based on the existing empirical literature. Section 3.6 builds a partial equilibrium model to simulate the propagation mechanisms based on the empirical findings.

The GFC also revealed major failings in many mainstream macroeconomic models in analysing the monetary side of the economy. The decline in macroeconomic volatility in advanced economies from the early 1990s until the crisis of 2007, a phenomenon known as the Great Moderation (GM), fostered not only risk-taking behaviour in the financial sector, but also led to complacency among policy makers and macro-economists. Most macroeconomic models depict a world with rational agents, efficient markets and general equilibrium, where the financial sector simply does not exist in the models. Much of this theory did not help in forecasting the crisis and central bank models based on this approach performed particularly poorly. According to such theory, banks take deposits from savers. Some deposits are then kept as reserves, while the rest is lent to borrowers. Under perfect competition, the banking sector is merely an intermediary, which allocates funds between alternative investment projects.

[4]In macroeconomics, considering the scale of the population under investigation and the significant financial and personal costs required for data collection, it is almost impossible for an individual researcher to collect primary data for analysis. Hence, we have to rely on published data sources from various official and commercial organisations.

Therefore, in light of the weaknesses revealed in many of the macroeconomic models concerning the monetary side of the economy, the third essay (Chapter 4) is devoted to modelling practice. The chapter firstly provides a literature review on the development of macroeconomic models before the GFC and the potential direction of future development (Section 4.2). As one of the few economists recognised to have successfully predicted and modelled the GFC (Schlefer, 2013), Section 4.3 follows in the footsteps of Godley and Lavoie (2007) and demonstrates the crucial components of a theoretical Stock-Flow Consistent (SFC) model. A major contribution of this chapter is to construct a fully estimated empirical SFC model for the UK (Section 4.4). It adds a financial sector to the UKMOD developed by Gudgin et al. (2015). As a general equilibrium model, it not only enables us to explore the interactions between the financial sector and the wider economy based on empirical data, but also to simulate the credit boom prior to the GFC.

2. Global Imbalances and the Financial Crisis

2.1. Introduction

Global economic stability is one of the essential prerequisites for economic development. In an increasingly globalised economy, identifying the driving forces behind persistent global imbalances and their economic consequences has substantial economic implications not only for advanced economies but also for developing countries. For instance, a sudden cessation of capital flows from surplus countries to deficit countries would require the latter to export more than before. However, if the previous capital flows went mainly into non-export sectors (e.g., housing) instead of the goods and services sector, then the deficit countries would have to reduce their imports of goods and services from the surplus countries. As this downward spiral continued, the world economy would enter a recession.

At the peak of the GFC, the world economy recorded its first negative GDP growth in many decades, global trade collapsed, and unemployment rose dramatically, especially in advanced economies. Despite the unconventional policies that were adopted by major central banks, such as cutting policy rates to the zero lower bound and vastly expanding their balance sheets, in the second quarter of 2013, the US and UK economies fell below their 1980–2007 growth trend by 14 per cent and 18 per cent respectively (Wolf, 2014). Recessions in advanced countries, in turn, imposed a heavy toll on the export sectors of developing countries. Hence, rebalancing the global economy has become one of the most frequently mentioned phrases in the global economic reform agenda.

Although the debt flow imbalances have improved since 2006, with the US trade deficit in particular narrowing somewhat, debt stock imbalances remain a major threat to the stability of the world economy, according to the IMF (2015). In order

to avoid a financial crash of similar magnitude to that of 2008 and safeguard global economic stability, more research on global imbalances is urgently needed. This chapter seeks to deepen the understanding of a specific economic phenomenon—global current account imbalances—by examining various channels, including the impact on economic stability and sustainability, the link with financial crises, and the relationship with internal imbalances.

A series of recent working papers from the Bank for International Settlements (BIS) lay out the conceptual ground and suggest a new direction for research into global imbalances. The empirical evidence indicates that focusing solely on current account imbalances can divert attention away from the leading causes of macroeconomic instability — monetary factors. Once the research focus has made a clear distinction between savings and financing, which was overlooked in the previous literature, then both the analytical framework of the GSG hypothesis and its policy implications become quite shaky (Borio and Disyatat, 2015).

The chapter is structured as follows: Section 2.2 describes the entire timeline of the GFC. It also summarizes the economic consequences and the commonly agreed upon causes. Section 2.3 provides a detailed account of the theoretical framework of the GSG hypothesis. Empirical evidence from both economic history and some stylised facts are also discussed. Section 2.4 focuses on the two alternative theories, the endogeneous money (EM) creation and the global financing glut (GFG) hypotheses, that challenge the GSG hypothesis.

2.2. The 2007-09 Financial Crisis

2.2.1. Timeline

The sub-prime crisis in the US in 2007 is widely acknowledged as the trigger of the GFC. The National Bureau of Economic Research (NBER) has identified all the peaks and troughs of the US business cycles since the late 19th Century. Using the turning point method, the researchers conclude that the 2007-09 economic recession began in December 2007 (the peak) and ended in June 2009 (the trough). This section briefly describes how the crisis unfolded during that period (See Fig. 2.1).

In April 2007 the largest US subprime lender, New Century Financial Corporation, filed for bankruptcy. Four months later another American sub-prime giant,

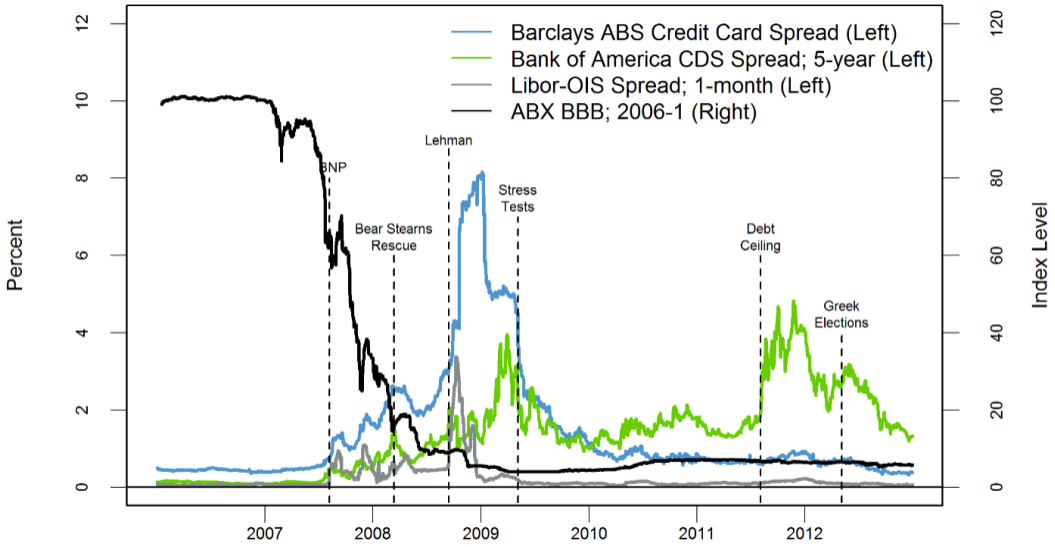
Ameriquest, failed. BNP Paribas[1] soon suspended claims from investors, worth US$2.2 billion, in three money market funds that specialised in subprime mortgages, which were exposed to substantial losses. As the majority of US mortgages are financially engineered by investment banks and widely sold to institutional investors in the global market as mortgage-backed securities (MBS), fear of the collapse of the US subprime mortgage market quickly spread to other regions in the world, especially Europe. Given the size of the derivatives market, there was much uncertainty over the potential loss and the exposure of each bank. The interbank lending market went into distress and sources of financing quickly dried up. The European Central Bank (ECB) injected EUR95 billion into the banking system and then another EUR61 billion on 8th August and 9th August. The sterling LIBOR rate shot above the Bank of England (BoE) base rate and hit a new high since1998.

The liquidity support facility from the Bank of England did not prevent the bank run on Northern Rock[2]. It was the first bank run in the UK in 150 years. The UK government had to guarantee all existing deposits and temporarily nationalise Northern Rock in February 2008. Similarly, in the US, the problem was extended to systemically important financial institutions. Bear Stearns was an early casualty. As one of the major investment banks, Bear Stearns and its subsidiaries were deeply intertwined with other major financial firms through asset-backed securities (ABS) and other open derivative contracts, with trillions on its balance sheet. Bankruptcy could threaten the stability of the entire global financial system. The Federal Reserve (Fed) reached an agreement with J.P. Morgan to facilitate the purchase of Bear Stearns for US$240 million in March 2008[3]. The world oil price continued to climb, resulting in inflationary pressure over this period. Stagflation became a significant concern for the Fed. Both interest rate policy and liquidity management policies were ill-equipped to deal with such a situation. By mid-July, the oil price saw a dramatic decline, which allowed more room for the Fed to extend the emergency lending programme to the financial system.

The world financial market entered a full-blown crisis by September 2008. On 7th September the US government had to bail out two mortgage finance giants, the Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac) due to the continuous weakening of the US

[1]The second largest bank in France and one of the largest in the world by assets.
[2]Northern Rock was the UK's fifth largest mortgage lender. It started as a building society and became Northern Rock bank in 1997.
[3]The Fed provided US$30 billion of funding.

Figure 2.1.: Stages of the GFC



Source: Bernanke (2018)

housing market. As government-sponsored enterprises, both institutions were supposed to generate revenue mainly through insuring mortgage debt, but a large share of their businesses was actually from making and selling MBSs. A week later Merrill Lynch and Lehman Brothers, both exposed to huge losses due to their heavy involvement in selling collateralised debt obligations (CDO)[4], were no longer able to sustain their business. The former was purchased by the Bank of America for US$50 billion, while the latter was allowed to go bankrupt, after a series of rescue attempts, by the US government on 15th September 2008. The fall of Lehman Brothers delivered a message that not all heavy-weight financial institutions would eventually be bailed out. On the same day, credit rating agencies downgraded insurance company American International Group (AIG), as it had been insuring banks against losses on their CDOs through credit default swaps (CDS)[5]. AIG ran into acute liquidity difficulty as losses on CDOs mounted rapidly. Given the size of AIG's consolidated total assets (over US$1 trillion), had it been allowed to go bankrupt, many banks that bought the CDSs from AIG would have also collapsed. Considering its systemic importance, the US government was forced to step in again to provide an emergency

[4] A type of ABS that is used to refinance MBS.

[5] A CDS is similar to insurance. The issuer receives a regular payment stream from the buyer in return for promising to insure against potential default from a particular exposure, for instance losses from MBS.

loan of US$85 billion on 16th September 2008[6]. As market uncertainty continued to increase the domino effects grew in power.

Europe also went through a wave of nationalisation of financial institutions and financial rescues, as liquidity froze in the global financial system. The UK government pushed through the merger between Lloyds TSB and Halifax Bank of Scotland (HBOS) on 18th September after experiencing a day of wild fluctuations in share prices. HBOS was the largest mortgage lender in the UK and Lloys TSB was ranked the fourth at the time. Together the two held one-third of the UK's savings and mortgage market. The stock market volatility had led to a temporary prohibition of short-selling by the Financial Services Authority (FSA) and the Securities and Exchange Commission (SEC). In October 2008, the UK government spent £37 billion to bail out the Royal Bank of Scotland (RBS), the largest bank by asset in the world at the time, and the newly merged HBOS-Lloyds TSB. In addition, the BoE also provided Emergency Liquidity Assistance (ELA) to HBOS and RBS on a large scale from early October[7]. The intra-day peak amounted to £61.5 billion (Plenderleith, 2012). The Icelandic government bought the domestic branches of Blitnir Bank, Glitnir and Lansbanki, but could not afford their foreign branches. The Governments of Belgium, the Netherlands and Luxembourg together invested over US$16.6 billion to purchase 49 per cent of shares of the Fortis Bank. The shares held by the Belgian government were eventually taken over by BNP Paribas, but the Netherlands nationalised its domestic holdings.

On 3rd October the US House of Representatives finally passed the US$700 billion Troubled Asset Relief Programme (TARP) after it had been rejected by Congress in an earlier round. Despite the vast amount of capital injected into the banking system to prevent collapse, it was still not enough to prevent the global economy from falling into a deep recession. Even though the US government passed the TARP, the stock market fell by 40 per cent, of which financial company stocks fell by over 80 per cent. Isolated interventions were no longer sufficient to calm the chaos; there was a need for a coordinated response from all major economies. On 8th October major central banks in the world[8] made a coordinated effort to stabilise the financial market by cutting the base rates by 0.5 per cent. On 10th October,

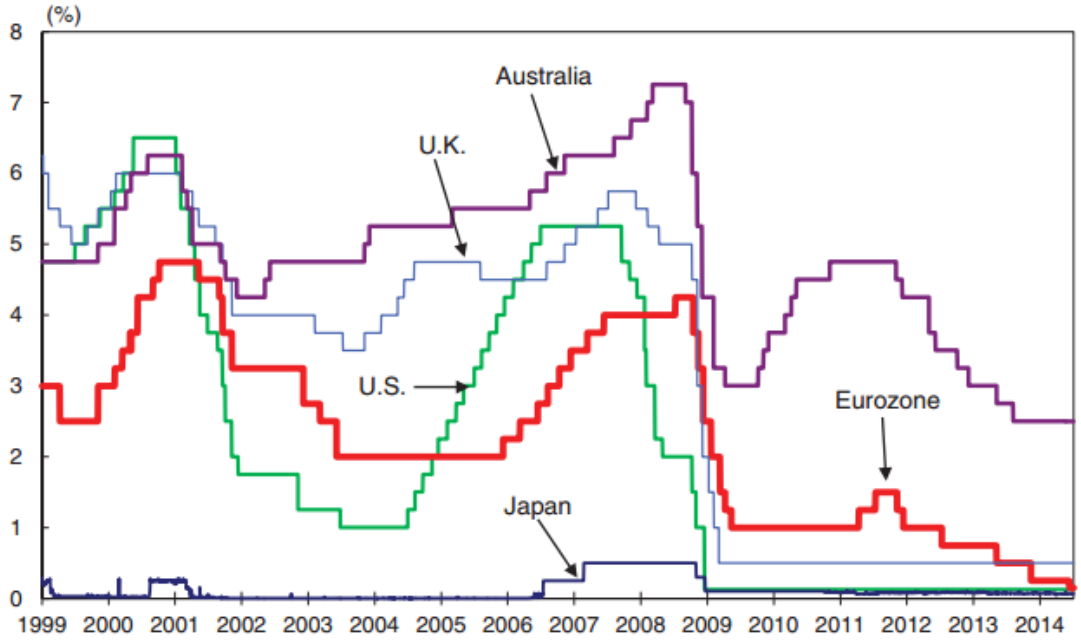
[6]The rescue cost the US Treasury and the Fed amounted to US$182.3 billion in total by March 2009.

[7]In order to stablise the financial market this information was not disclosed by the BoE until a year later.

[8]Including the US, UK, China, ECB, Canada, Sweden and Switzerland.

in order to support economic growth and stabilise the global financial markets, the G7 agreed to a five-point Plan of Action[9] to keep the credit liquidity flowing. The market was not easy to persuade. The Dow Jones Industrial Average recorded the highest daily volatility in its 112-year history.

Figure 2.2.: Interest rate dynamics of major central banks



Source: Koo (2014)

On 4th November Barack Obama was elected in the middle of this economic turmoil. With support from both houses of Congress, the new administration pledged billions of government spending, in addition to TARP, to provide infrastructure, unemployment insurance and health care. Later in the month, the Fed announced the first round of Quantitative Easing (QE)[10] in order to drive down bond yields and inject liquidity into the system. This first round of QE lasted until 2013. Trillions of dollars were used to purchase Treasury securities, MBSs and agency bonds. In December the Fed cut the overnight rate to the lowest in history between 0 and 0.25 per cent, but it has come too late. The US economy entered a deep recession, and

[9]The Action Plan included the following steps: 1. prevent systematic important financial institutions from collapsing; 2. maintain financial liquidity in the global credit and money markets; 3. support the nationalisation of the financial institutions when necessary; 4. implement better deposit protection scheme for savers; 5. Ensure the information of banks' loss position is well disclosed. (Elliott et al., 2008)

[10]The BoE followed the same in March 2009 and the ECB continues to do so even today.

it was the worst slowdown since Q1 1982.

In January 2009 President Obama took office. US banks reported an accumulated loss of over US$1 trillion since the beginning of the subprime mortgage crisis. The credit contraction lowered aggregate demand, which is reflected in employment figures. Unemployment reached 11.6 million in the US, and the unemployment rate rose to 7.6 per cent from 4.9 per cent in 2008. In February Congress approved the American Recovery and Reinvestment Act proposed by the Obama administration. This fiscal stimulus package was worth US$787 billion, containing many of the critical policies promoted during Obama's campaign, of which US$288 billion was for tax reduction, US$224 billion for unemployment benefits, and US$275 billion for the provision of public works. The next day the Homeowner Stability Initiative, worth US$75 billion, was announced directly to help as many as nine million at-risk homeowners avoid foreclosure by either restructuring or refinancing their mortgages. The 5th March marks the most significant drop in the Dow Jones Index, (53.4 per cent from its peak on 9th October 2007) in any bear markets since the Great Depression of 1929. The BoE cut the bank rate to 0.5 per cent, which was the lowest in its 300-year history[11]. The Fed surprised the market with a round of mega-scale quantitative easing, of over US$1 trillion, in order to compensate for the credit contraction. Later that month the US Treasury Department outlined a new framework for the financial reform and banking regulations, officially known as the Dodd-Frank Wall Street Reform and Consumer Protection Act[12]. The Act provides measures to contain systemic risks in the financial system.

In April 2009, the Obama administration launched the Making Homes Affordable Programme further to save homeowners from foreclosure. As part of the programme, the Homeowner Affordable Refinance Program (HARP) aimed to revive the housing market. Up to 2 million credit-worthy homeowners, who were experiencing liquidity difficulties, could refinance at lower mortgage rates. Unfortunately, the banks became too risk-averse. After two years only 810,00 homeowners had benefited from the programme. The newly formed G20 group held a Summit in London on 2nd April 2009. The G20 committed a US$5 trillion fiscal expansion to safeguard employment, boost economic growth and reform the financial system. An additional US$1.1 trillion was allocated to support the expansion of IMF lending capacity which could serve the immediate liquidity needs from several emerging economies. Fed's

[11]The BoE lowered the rate again after the Brexit vote.
[12]The legislation bill was passed in July 2010.

stress test in May found that losses of the 19 largest bank holding companies could amount up to US$600 billion in 2009 and 2010. In order to maintain an adequate level of capital, ten of them would require an additional capital of US$185 billion. In June 2009, most of the advanced economies began to show signs of recovery. In less than a year, the focus of concern shifted to the sovereign debt crisis in Europe. The ECB consequently lowered its interest rate to the zero-lower bound, but the Eurozone has continued to experience strains even today.

2.2.2. Economic consequences

This section discusses the economic consequences of the GFC. A systemic financial crisis differs fundamentally from a typical financial shock. Firstly, a systemic crisis imposes much higher economic and social costs.

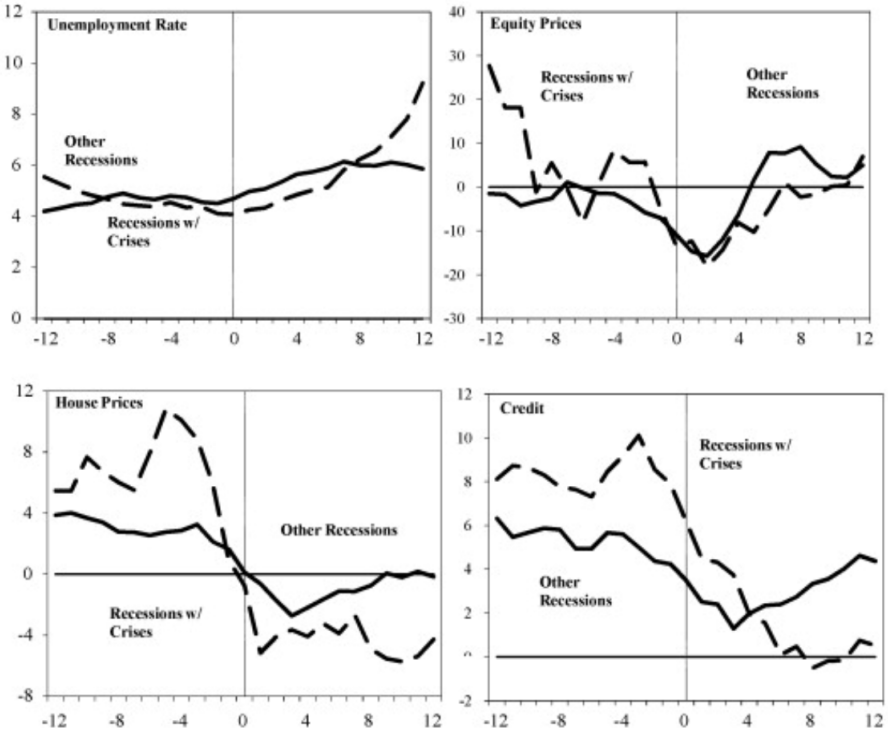
Financial crises and economic downturns are mutually reinforcing events. As financial losses occur, financial institutions experience liquidity distress due to a frozen interbank lending market and are reluctant to offer new loans. Borrowers are constrained in further lending, which worsens the economic conditions of the real sector. Reinhart and Rogoff (2014) conducted extensive research on 100 systemic banking crises between 1800 and 2011. The output loss averages 11.5 per cent, and it takes 8.3 years to recover. For example, high unemployment rate (more than 10 per cent) persisted in the US for more than a decade after the Great Depression. Consumption, as a critical welfare measure for households and a significant component of GDP, fell by 18% between 1929 and 1933 (Mian and Sufi, 2016).

Claessens et al. (2010) looked at the performance of several macroeconomic and financial variables for 21 OECD countries between 1960 and 2007. They found that recessions associated with credit and housing bubbles can cause the unemployment rate to increase continuously for up to 3 years. In contrast to a typical recession, an amplified boom-bust cycle effect appears to be in both credit growth and house prices in recessions associated with a financial crisis. During a crisis-led recession, it also takes longer for the stock market to recover. Reinhart and Rogoff (2008) also added fiscal costs into the matrix. In the five major crises,[13] they studied the fiscal costs of cleaning up the banking crisis ranged from 6 per cent of GDP (Sweden

[13]Spain (1977), Norway (1987), Finland (1991), Sweden (1991) and Japan (1992), where the starting year is in parentheses.

in 1991) to more than 20 per cent (Japan in 1992). The level of public debt also increased very quickly.

Figure 2.3.: Unemployment, House Prices, and Financial Variables



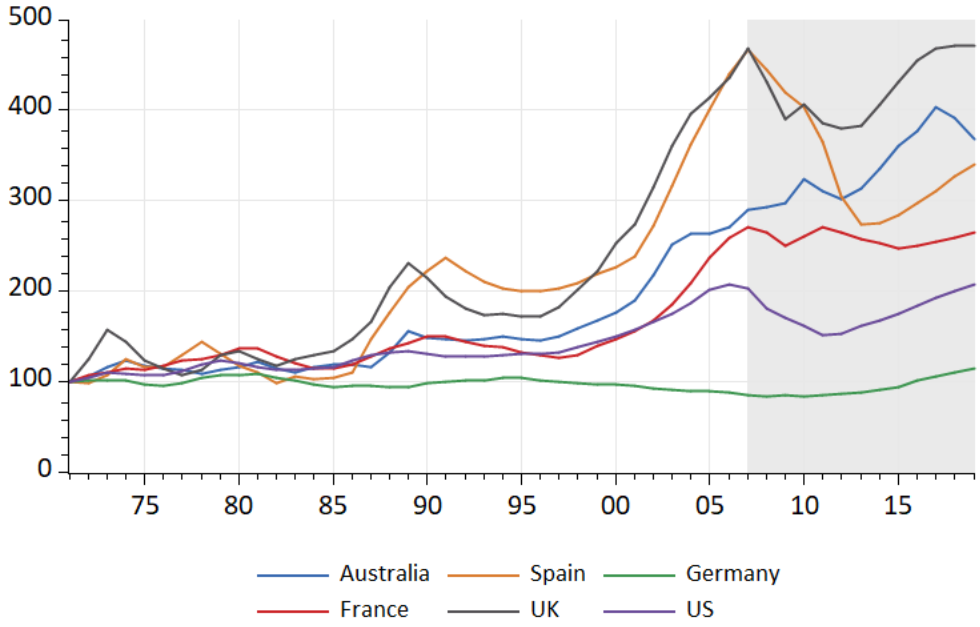
Source: Claessens et al. (2010); the units on the Y Axis are year-on-year percentage changes and the X Axis is measured by quarters with 0 being the quarter that enters into the recession (i.e. passing the peak level of output); the solid line represents the changes that are irrelevant to the financial crisis and the dashed line represents the changes that are relevant to the financial crisis.

Secondly, a systemic crisis requires much more aggressive policy responses to reduce the risk of damage to the economy. In a market economy, it is desirable that reckless players should fail under an isolated financial shock. As market adjustment takes place, they should bear the direct consequences of their decisions. In a systematic crisis, monetary policy becomes much less effective in mitigating the economic damage. Standard liquidity provision or lower policy rates from the Central Bank is the typical response depending on the nature and depth of the recession. However, in a systemic crisis, failure can be contagious, and the rest of the system also becomes destabilised. An excessive build-up of leverage makes economic agents less responsive to the standard monetary policy tools. A much larger fiscal stimulus, much more aggressive and much less conventional monetary policy response are necessary.

In terms of the financial system, providing guarantees and protection to limit the incentive and risk of runs are essential.

The 2007-09 financial crisis led to the worst global downturn since the 1930s. From 2008 to 2011 real consumption in the US fell by almost 2.5 per cent. Real house prices in the US plunged by 26.9 per cent between 2006 and 2011. The Obama administration did not deliver economic recovery as promised. Negative equity and foreclosed homes were widespread in the US. No president since Roosevelt has won an election with an unemployment rate at near 10 per cent. Traditional macroeconomic policies faced a dilemma. Monetary policy was approaching the zero-lower bound while there was little room for expansionary fiscal policies.

Figure 2.4.: Real House Price Index (1971=100), selected countries, 1970 - 2018



Source: OECD, own calculation

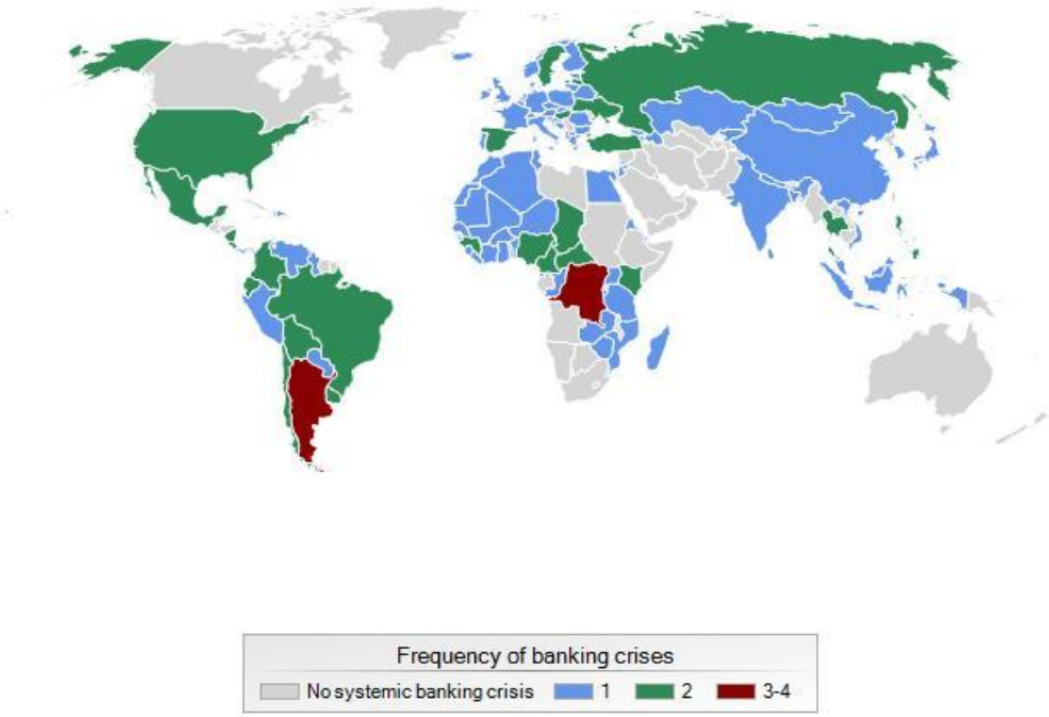
The financial crisis originating in the US caused devastating damage to the world economy through the highly integrated global financial and trade networks. According to OECD data, real house prices in more than half the OECD countries declined sharply over the same period (See Fig. 2.4). At the peak of the GFC, the world economy recorded the first negative GDP growth in many decades; global trade col-

lapsed[14], and unemployment rose dramatically in many advanced economies. Despite the unconventional policies adopted by major central banks - cutting policy rates to the zero lower bound and engaging in vast expansions of balance sheets[15] - in the second quarter of 2013 the US and the UK economy had fallen below its 1980-2007 trend by 14 per cent and 18 per cent respectively (Wolf, 2014). Barnichon et al. (2018) estimate that the total output loss in the US is equivalent to a lifetime present-value income of US$70,000 for every American citizen. The recession in advanced countries, in turn, imposed a heavy toll on export sectors in developing countries.

Thirdly, despite its frequent appearance and the hugely damaging impacts on the economy, means of managing the crises are limited. Between 1970 and 2011, there were 147 banking crises across the globe, of which 39 were twin crises, and 8 were triple (Laeven and Valencia, 2012). Figure 2.5 shows the frequency of systemic banking crises in a variety of countries. Crises like the Great Depression or the Great Recession are rare, especially when in the same country. This is also why such events can be so difficult to predict and manage. In his lecture at Yale University, Geithner (2017) drew an analogy between acute systemic crises and natural disasters such as a flood. Although everyone knows a residential area is affected by flood every few years, they still decide to reside near the flood plain as small-scale floods cannot significantly harm their living standards. The further inland one lives, the safer properties are as a catastrophic flood may only occur once in a lifetime. However, when such a rare event occurs, it destroys most residential properties in the area. People will stay further away from the flooded area for some time and start to move back again as the painful memories wane. This process is very similar to Minsky's Financial Instability Hypothesis (FIH). The role of collective memory is critical. If the memory is dominated by a relatively benign period, such as the Great Moderation of 1986 to 2006[16], then it is likely that economic agents form a positive view and project it forward. However, people tend to be more risk-averse when catastrophic events are still fresh in memory. The psychological constraint tends to relax over time. Irrational Exuberance was used by Alan Greenspan and Robert Shiller to explain the possibility of overconfidence in the market and eventually leading to market panic and economic crash.

[14]World total value of merchandise trade (including both exports and imports) fell by more than 20 per cent between 2008 and 2009.
[15]Better known as quantitative easing (QE).
[16]See sec. 2.2.3 for more details

Figure 2.5.: Crises between 1970 and 2011



Source: Laeven and Valencia (2012)

If irrationality is deeply rooted in human nature, then future crises seem to be inevitable, but it is still essential to learn from the last crisis so that we can better respond next time. The Financial Crisis Inquiry Commission (FCIC) concluded that the 2007-09 financial crisis was, unlike natural disasters, fundamentally avoidable since it was the result of human action and inaction. There were early warning signs, but alas they were not taken seriously.

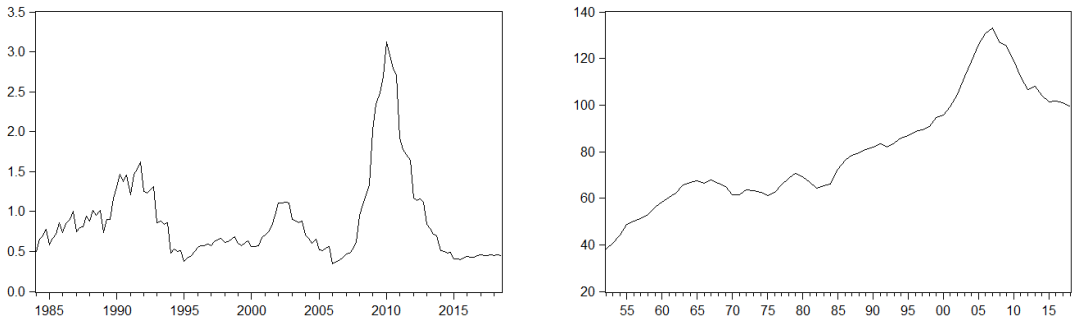
2.2.3. Causes

Stability is destabilising. This is the crucial insight of Hyman Minsky's Financial Instability Hypothesis (FIH) (Minsky, 1986). Before the GFC, most advanced economies had been through a period known as the Great Moderation. The term was first used by Stock and Watson (2003) based on their observations on moderated business cycle volatility between the mid-1980s and early 2000s, which is widely used by other economists to describe this period (Bernanke, 2004). With great financial stability comes, according to Minsky, the inevitability of a great financial

crash. The Great Moderation sets a perfect scene for the crisis. Drawing on the FIH, McCulley (2009) uses three types of Minsky income-debt relations to describe the US subprime crisis: hedge, speculative, and Ponzi. Hedge financing borrowers are those who have traditional mortgages. Their cash flows can fulfil all the debt obligations. Speculative borrowers may find it challenging to pay off the principal, but they can still meet interest payment obligations through income cash flow. The subprime borrowers are mostly the Ponzi borrowers as their income cash flows are not enough to cover either principal or interest payment. Such borrowers must rely on an ever-increasing asset prices to keep their debt afloat.

With reduced volatility of growth outcomes, the memory of the severe crisis gradually faded. Households and businesses became less and less risk-averse. Lenders were more confident about providing loans to speculative and Ponzi borrowers because the US housing boom backed these loans. More borrowers were more confident that the value of their homes would rise so that borrowing a large amount relative to their income would pay off. As a result, the number of subprime mortgages increased dramatically before the GFC. The long rise in debt to income over time (See Fig. 2.6) is an important feature distinguishing a systemic from a normal financial crisis (Dalio, 2018).

Figure 2.6.: Net loan losses ratio for all US Banks (left) and US households debt to income Ratio (Right)



Source: FRED and OECD

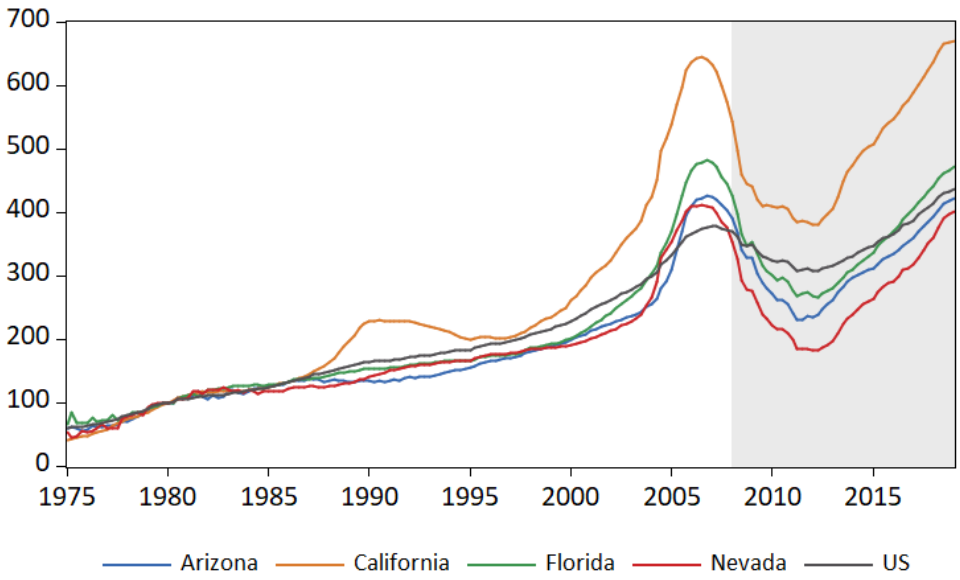
FCIC (2011) identified ten major causes of the GFC. According to Claessens et al. (2010), four are also commonly found in previous episodes of financial crises. These are the focus of this subsection.

Credit and Asset Bubbles. According to the FCIC foreign capital inflows fuelled by the vast amount of foreign reserves built up in China, other large developing coun-

tries and oil exporters, through trade surpluses, have significantly lowered interest rates in the US and elsewhere. As the yield (or risk) spreads continued to narrow up until the end of 2006, financing risky investment became less costly, which led to credit bubbles in deficit countries. This explanation echoes the famous global imbalance story, which was seen by many as the primary cause of the 2007-09 financial crisis (Bernanke, 2015). As one of the focal points of this thesis, the global imbalance will be discussed thoroughly in the next section.

Credit bubbles always go hand in hand with asset bubbles. The housing market was central in the last episode of the asset bubble. Between the late 1990s and 2007, the average house price in the US climbed to a historic high. In some regions such as California, Nevada, Arizona and Florida, also known as the sand states, the increase in house prices was even more pronounced. The fast rise in house price was partly due to the faster population growth in these states that created more demand for housing. Also, the land use restrictions in some areas further exacerbated the supply-demand gap (FCIC, 2011). However, these factors cannot explain why there was a nationwide housing boom in the US.

Figure 2.7.: House Price Index for Sand States



Source: US Federal Housing Finance Agency, created by the author

The nationwide mortgage bubble is a more significant contributor to the housing

boom in the United States and Europe (Duca et al., 2010). The surge in housing prices and mortgage lending are two reinforcing forces. Shared expectations of future price movements are a self-fulfilling prophecy. As both lenders and borrowers become overly optimistic about future housing prices, the demand for housing will be financed by more mortgage lending, which in turn raises the housing price and demand for mortgages. Since the 1980s credit availability has increased dramatically in the US and UK through the housing market. There are two channels: lower down-payment requirements and collateral effect (Ryan-Collins et al., 2017). The former allows households to access a mortgage with less saving, while the latter makes it easier for households either to increase debt or refinance at a lower rate via home equity withdrawal. The falling mortgage rates since the 1980s have also facilitated the process. Choi et al. (2016) found that, instead of investing in the stock market, people in the Sand States were more likely to purchase homes for investment purposes. These states had more than double the mortgage originations and defaults, which amplify the housing cycle. When the demand of all credit-worthy borrowers is met, in order to continue the boom cycle, the financial institutions gradually turn to non-traditional borrowers, who previously would have been considered risky. These borrowers cannot service mortgages in the long term. Mortgage originators provide the initial loan in the expectation that the accumulating home equity will soon be refinanced in more sustainable mortgages. Ultimately, like all bubbles, when it bursts (housing prices collapse) the market enters a reverse spiral.

Margin Loans[17] **and Securitisation**. Before the crisis, much of the borrowing is financed through the expansion of non-traditional mortgages[18]. Large numbers of subprime mortgages[19] were issued by firms like Countrywide, Ameriquest and New Century. The financial terms were beyond borrowers' ability to repay through their income cash flow. In order to reduce the probability of early default, many subprime mortgages offered adjustable rates (ARMs). ARMs lower borrowers' payment in the initial periods and add to the outstanding loan balance and some products

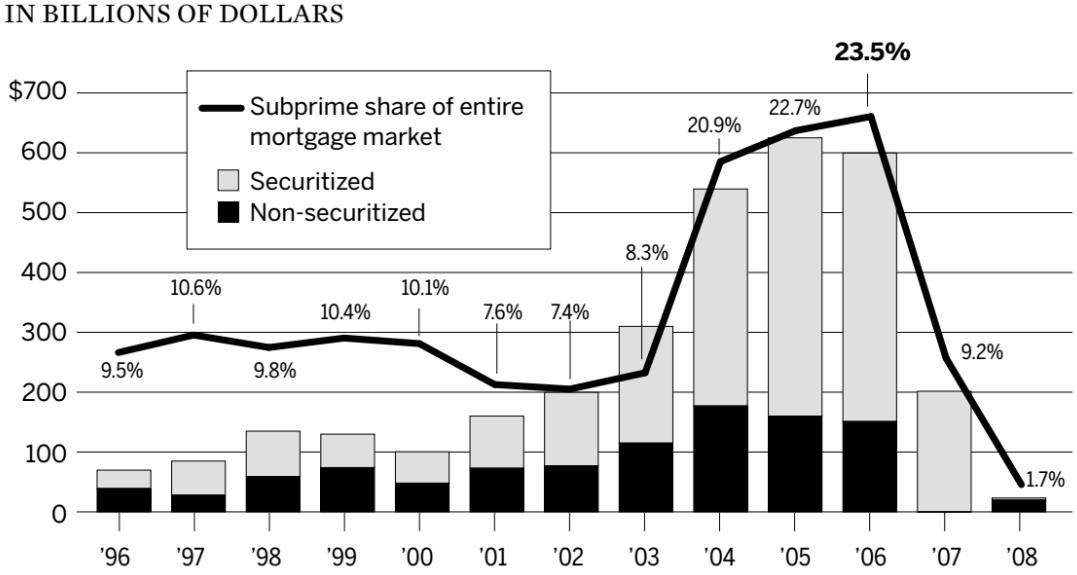
[17] These are loans taken out for investment either in the stock market or managed funds. It could be speculative or ponzi financing in Minsky's terms.

[18] The standard mortgage in the United States has a 30-year term, with fixed interest rates. Borrowers pay interest and an amortisation of the loan per annum. Alternatively there are mortgages with adjustable interest rates for all or part of the term ("ARMs", 2/28, 5/25 or 5/1, 7/23 or 7/1 etc.), with rates adjusted with certain spreads based on a reference rate.

[19] According to Mayer et al. (2009), the borrowers of subprime loans generally have low credit scores, tarnished histories, and limited saving available for down payment. Target borrowers of Alt-A loans are relatively more credible than subprime borrowers. They either have minor credit quality issues or cannot provide all the required documentation for a conventional mortgage.

even offer negative amortisation (Bernanke, 2013). In normal circumstances, an ever-increasing house price should constrain demand, but with the increase in non-traditional mortgages, affordability becomes less an issue in the short term. If the appreciation of property values continues (e.g. 10 per cent per annum), the risk of default is limited: a 100 per cent mortgage will become an 80 per cent mortgage after a couple of years. As a result, the use of subprime mortgages increased rapidly from 2003. The share of subprime mortgages in the entire US mortgage market jumped from 8.3 per cent in 2003 to 23.5 per cent in 2006, which marks an increase of US$300 billion in the absolute amount. Following the burst of the housing bubble, the subprime market also collapsed.

Figure 2.8.: US Subprime Mortgages and Securitization



Source: FCIC (2011)

Securitisation amplifies the impacts of the collapse of the subprime mortgage market. The asset/liability structure of a traditional bank is inherently fragile, as the assets are predominantly long-term, illiquid loans, such as mortgages, while the majority of liabilities are short-term deposits that can be withdrawn on demand. The liquidity mismatch creates a vulnerable system that is subject to runs and panic. Post-crisis reforms focus more on improving banks' short-term liquidity resilience. The amount of liquid assets on the banks' balance sheets must be enough to withstand a 30-day stress test (BIS, 2013). Securitisation was initially introduced in the 1990s by having long-term assets bundled and sold to other investors on the global secondary

market. It enables the banks to effectively offload long-term assets, with investors earning payment streams from the securitised assets that they buy. The sale of mortgage-backed securities (MBSs) allows banks to focus on retail banking and risk evaluation, and on managing mortgage repayment. Such financial innovation is considered positive as long as the quality of the mortgages is good. However, as the share of subprime mortgages increases, the risk associated with MBSs also increases. Slovik (2012) argued that the capital requirement set by the Basel Accord[20] was one of the contributing factors to the explosive growth of these financial innovations prior to the crisis. They are designed to circumvent regulatory requirements, such as the minimal Capital Adequacy Ratio (CAR). Therefore, a higher CAR requirement imposed by Basel III is likely to be counterproductive, as it continues to encourage such skewed incentives.

Meanwhile, collateralised debt obligations (CDOs) add another layer of complexity and interconnectedness to the already complicated financial system. Depending on the preferences for each market segment, financial engineers slice MBSs into several pieces, with each piece having a different profile in terms of risk, maturity and financial return. The highest tranche has priority (in terms of getting paid) as the banks start receiving a payment stream from the mortgage-backed borrowers. It is the safest layer, which also offers a lower interest rate than the lower tranches. The bottom tranche is tailored for investors who are less risk-averse and expect high returns. Such investors only get paid when there is enough payment coming through to the banks. If default rates are high, they will receive no return, because the payment stream will have been exhausted while passing through the upper tranches.

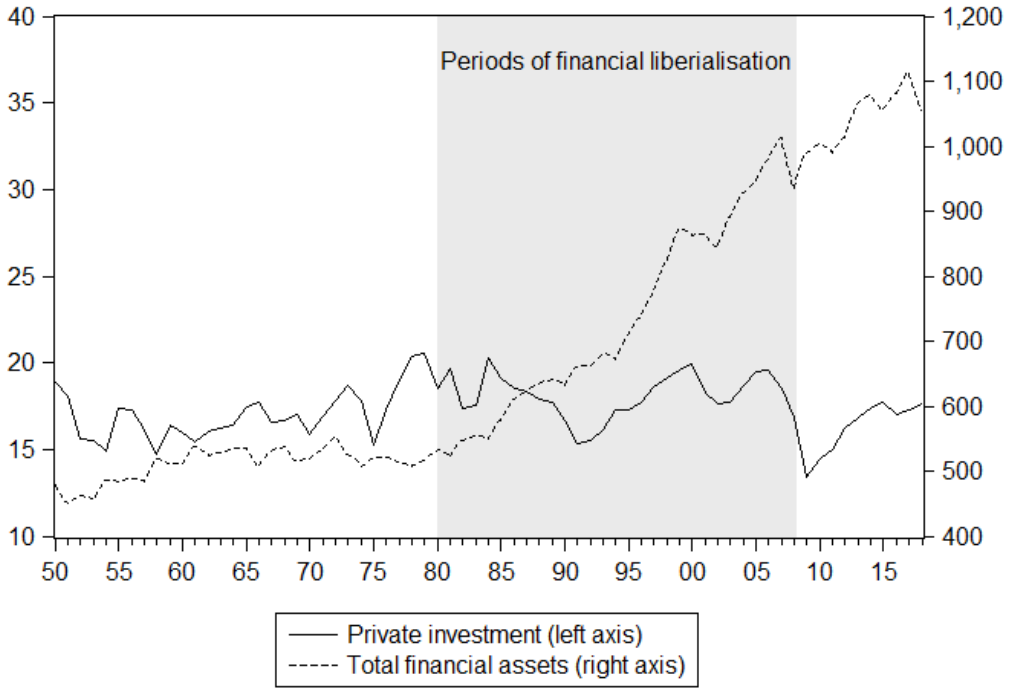
The development of credit-default swaps (CDSs) accentuates the domino effects in the global financial markets through the intermediation of insurance companies. CDSs are mostly insurance policies that protect banks from defaults on complex financial instruments. Although such products may reduce the exposure of banks to default risk (as long as the insurer remains financially sound), they technically separate the issuers of credit from the holders, which encourages risk-taking behaviour. When multiple counterparts suffer large-scale defaults on CDOs, insurance compa-

[20]The Basel II Accord is a revised capital framework of the 1988 Basel (I) Accord. It was released in June 2004. The framework expanded the previous standardised rules regarding minimal capital requirements along with other regulatory requirements. The bank is required to hold at least 8 per cent of regulatory capital over risk-weighted assets. Basel III further increased this ratio to 12.5 per cent as of 2020.

nies can face a severe shortage of liquidity (e.g., AIG), which can create massive destabilising forces.

Failure of gatekeepers. The GFC revealed major loopholes in global financial regulation. Since the 1970s, the US has gone through several waves of deregulation in the financial sector. During the Nixon and Reagan administrations, financial regulatory bodies experienced a decline in both their workforce and their budgets. For example, the number of employees of the Office of the Comptroller of the Currency (OCC) declined significantly between 1979 and 1982. Thus, supervisory capacity became increasingly limited when dealing with a financial system that was growing in size and complexity (White, 2012). At the same time, policy measures were implemented, and restrictions relaxed that allowed banks to grow in size and which encouraged competition. As a result, the volume of financial assets increased dramatically from the 1980s onwards, far exceeding the growth in GDP. Concurrently, multiple bank failures began to occur again, for the first time since the end of the Great Depression.

Figure 2.9.: Gross private investment and total financial assets, % GDP, US



Source: BEA data; created by the author

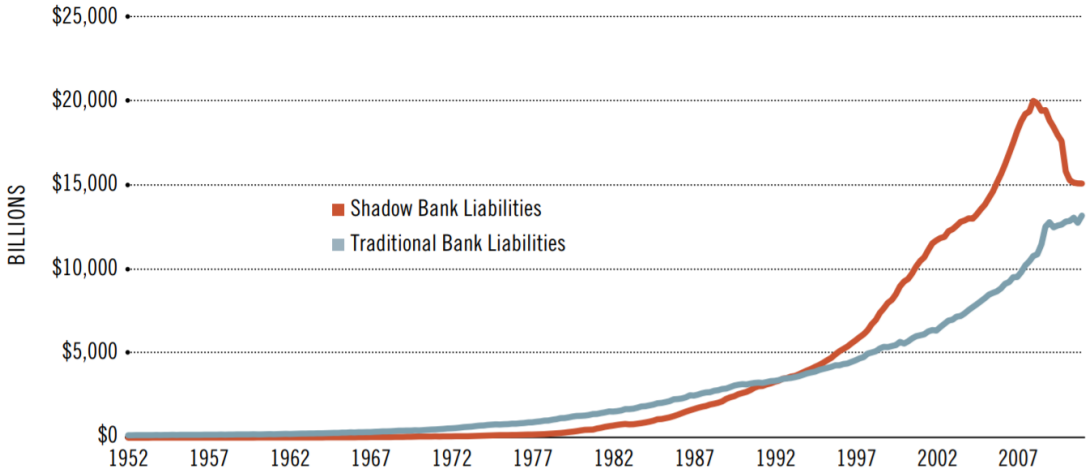
Panico et al. (2014) argued that the evolution of financial regulation was the result of compromises between different interest groups. The enforcement power of regulators was eroded by a political climate that was in favour of financial deregulation. Igan et al. (2009) found that between 2000 and 2006, mortgage lenders that had more securitised assets, more mortgages with higher loan-to-income ratios, and faster-growing mortgage–loan portfolios also lobbied the most to prevent tighter laws and regulations on mortgage lending. The lobbying power of these financial institutions significantly contributed to risk-taking behaviour before the GFC.

According to Bernanke (2013), the regulatory structure in the US did not keep up with developments in the financial sector. The structure had remained almost the same since the 1930s, and was segmented. Each regulatory body[21] was only responsible for a specific set of financial institutions. This micro-prudential approach was not sufficient for evaluating the systemic risks that affected the entire system. For instance, before the financial crisis, there was no federal-level regulator for insurance companies in the US. Each state was primarily in charge of regulating its own insurance companies. Smaller banks that were owned by large insurance companies (e.g., AIG) were under the supervision of the Office of Thrift Supervision. Clearly, a macro-prudential approach was needed if a broader picture of the stability of the financial system was to be seen.

The share of shadow banking (in terms of total liabilities) proliferated from the 1980s onwards. The shadow banking system refers to "credit intermediation involving entities and activities (fully or partially) outside the regular banking system" (FSB, 2018). After the early 2000s, the majority of borrowing came from the shadow banking sector. At the peak, total financial liabilities in the shadow banking sector were close to US$20 trillion. Shadow banks included investment banks such as Bear Stearns and Lehman Brothers, or government-sponsored enterprises (GSEs), such as Fannie Mae and Freddie Mac, or non-bank financial institutions, such as insurance companies and wholesale investors using the repo market and money market intermediaries to provide short-term loans. Although shadow banks share similar functions as traditional banks, they are not subject to the same level of regulation. During the credit boom, many risky financial products (including MBSs and CDOs) migrated to parts of the financial system that were less regulated and thus did not appear on traditional banks' balance sheets.

[21] Namely the Fed, the OCC, the SEC and the Office of Thrift Supervision.

Figure 2.10.: Shadow Banking



Source: Noeth and Sengupta (2011)

The FCIC (2011) concluded that the failures of credit agencies were an essential enabler of the financial crisis. Weak disclosure standards and underwriting rules may have encouraged irresponsible lenders to issue non-prime mortgages, but none of these risky mortgage-backed securities (e.g., CDOs) would have been sold so widely in the global financial market without the good ratings that were granted by the big three rating agencies[22]. Each trench of CDOs is rated differently based on its risk exposure. The safest tranche is typically rated with triple-A before the GFC. Although investors of the triple-A tranche receive lower interest rates than those invested in lower tranches, they are also the last to suffer from a loss should there be any repayment issues from the mortgages.

Rating agencies have an enormous influence on investor perceptions. Therefore, the firms that issue structured securities are highly incentivised to achieve high ratings. Some critics even claimed that the three big agencies sacrificed quality ratings for a lucrative share of the booming market. Moody's earned more revenue from structured products in 2006 (US$881 million) than its entire business did in 2001 (Alessi et al., 2013), but 83 per cent of its triple-A rated mortgage securities that year were downgraded. In another example, Citigroup purchased 4,499 subprime mortgages from New Century Financial in 2006 and eventually divided them into 19 tranches of MBSs (US$947 million). Around 78 per cent of the structured MBSs (US$737

[22]Standard & Poor's (S&P), Moody's, and Fitch Group

million) were rated with triple-A. The structure of the deal was very common before the financial crisis (FCIC, 2011). However, the agencies rejected such accusations by pointing out that ratings are a collective decision taken by committees, not by individual analysts, and that past mis-ratings were mainly due to the lack of transparency.

2.3. Global imbalances and financial crises

Bracke et al. (2010) defined global imbalances as 'external positions of systemically important economies that reflect distortions or entail risks for the global economy'. This definition highlights several key features of the phenomenon. Firstly, global (external) imbalances are a result of the internal imbalances of one or more economies. Secondly, such economies play systemically essential roles within the global economy. Thirdly, the imbalances originating within these economies will likely endanger global economic stability, and therefore, domestic distortions must be identified and examined so that the root causes can be traced and solutions found.

Accounting identities are useful for demonstrating how internal imbalances are linked to external ones. In any country, the gross domestic product (GDP) is the sum of domestic consumption (C), investment (I), government expenditures (G), and net exports, ($X - M$).

$$GDP = C + G + I + (X - M) \tag{2.1}$$

Much of the analysis of global imbalances concerns the imbalances in the current account (CAB). However, there are three components to CAB: the goods and services balance[23] ($X - M$), net primary income flows from abroad (NY), and net current transfers from abroad (NCT).

$$CAB = (X - M) + NY + NCT \tag{2.2}$$

[23]This is the dominant component in most countries.

By adding both (NY) and (NCT) to (2.1), we get the national disposable income $(GNDI)$,

$$GNDI = GDP + NY + NCT = C + G + I + CAB \tag{2.3}$$

Given that the national accounting concept of saving $(S = GNDI - C - G)$ represents what is left unconsumed from the gross national disposable income, after rearranging (2.3), we get:

$$S - I = CAB \tag{2.4}$$

From identity (2.4), we can note that current account positions[24] mirror the gap between domestic saving and investment. A CAB surplus (deficit) implies that domestic savings (investment) exceed domestic investment (savings), and the economy is acquiring net financial assets (liabilities) from the rest of the world. More importantly, this identity highlights an essential feature of global imbalances — deficit countries and surplus countries are conjoined, like the two sides of the same coin. In other words, the persistent and ever-expanding current account deficit observed in the US since the early 1990s cannot exist unless there are countries, such as China, Germany, and Japan, willing and able to run surpluses to match the size of that deficit. This identity underlines the fundamental reasoning behind the GSG hypothesis. Therefore, to further examine the hypothesis, we need stories from both ends to solve the puzzle.

If we further disaggregate the identity (2.4) into the private sector and government sector, then we get:

$$(S_p - I_p) + (S_g - I_g) = CAB \tag{2.5}$$

where subscripts p and g stand for the private sector and government sector respectively. The identity (2.5) shows that a large and persistent current account deficit

[24] Many analysts have not followed strict accounting rules. When they refer to current account imbalances, they are actually referring just to the goods and services balance.

in any country reflects either an over-indebted private sector or an over-indebted public sector (or even both), which raises concerns regarding its sustainability.

If one or more such economies also happen to be the main protagonists within the global economic system, then their internal imbalances can easily cause concern for the sustainability of global external balances. Rebalancing their internal imbalances can therefore potentially provide a way out of global imbalances. Notice that there is a difference between multilateral imbalances and bilateral imbalances. While a persistent multilateral imbalance signals internal imbalances, a bilateral imbalance can be the result of trading based on comparative advantage (McLaren, 2012). The following subsections review the causes of the current episode of global imbalances and provide a detailed account of the Global Savings Glut (GSG) hypothesis that links global imbalances to financial crises.

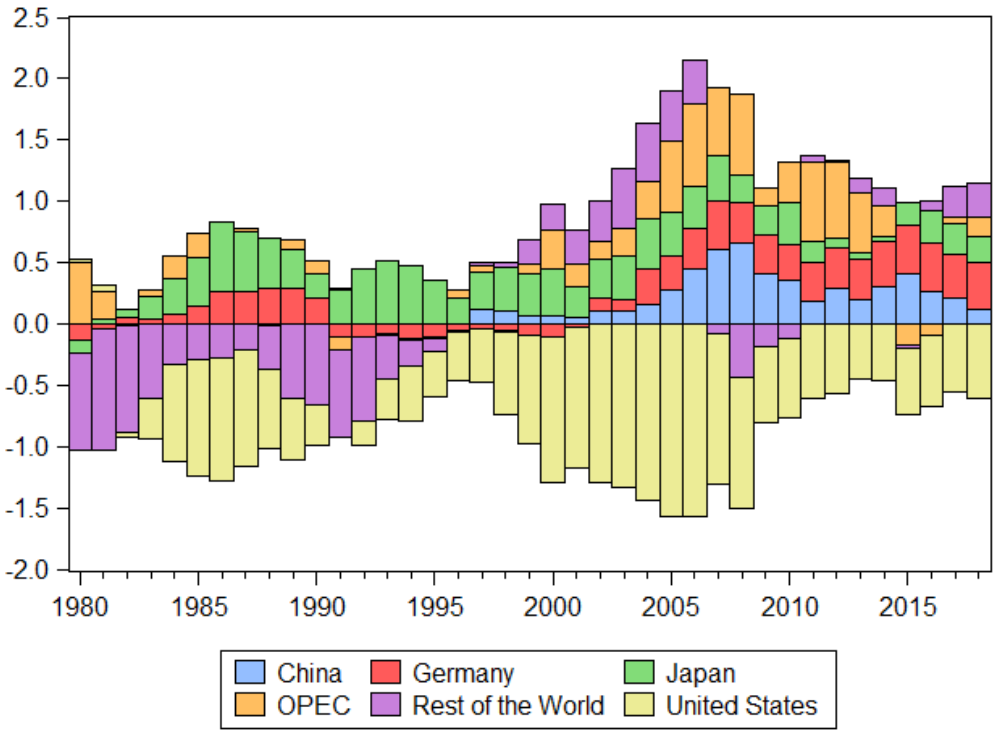
2.3.1. Causes of global imbalance

The US current account balance has been in deficit persistently since the early 1980s, while the dominant player on the surplus side kept rotating amongst a few countries, namely the big oil exporters, Japan, China and Germany. The imbalances seem to be mainly bilateral between the US and Japan in the 1980s and 1990s. New players, such as the oil exporters, joined the surplus side at the turn of 21st century, as the relative share of Japan gradually declined over time. Germany, another key surplus country in the 1980s, has re-established its surplus position. It has surpassed China and become the number one surplus country after 2013. China's share of the US surplus only became noticeable a few years before the crisis and never reached the level that the Japan had previously attained. (See Fig. 2.11)

The scale of the global imbalances reached its peak in 2006, which was just before the outbreak of the GFC. At the peak, China, Germany, Japan and the big oil exporters together accounted for nearly 75 per cent of world's total surpluses, while the US accounted for around 60 per cent of world's total deficits. The bilateral imbalance between China and the US accumulated rapidly just prior to the crisis. Although the imbalance moderated somewhat after 2008, it caught global attention once again when the Trump administration began threatening a trade war against China unless the Sino-American current account imbalance was addressed.

It is critically important to identify the nature of the US imbalances. If they are

Figure 2.11.: Current Account Balance, % of World GDP



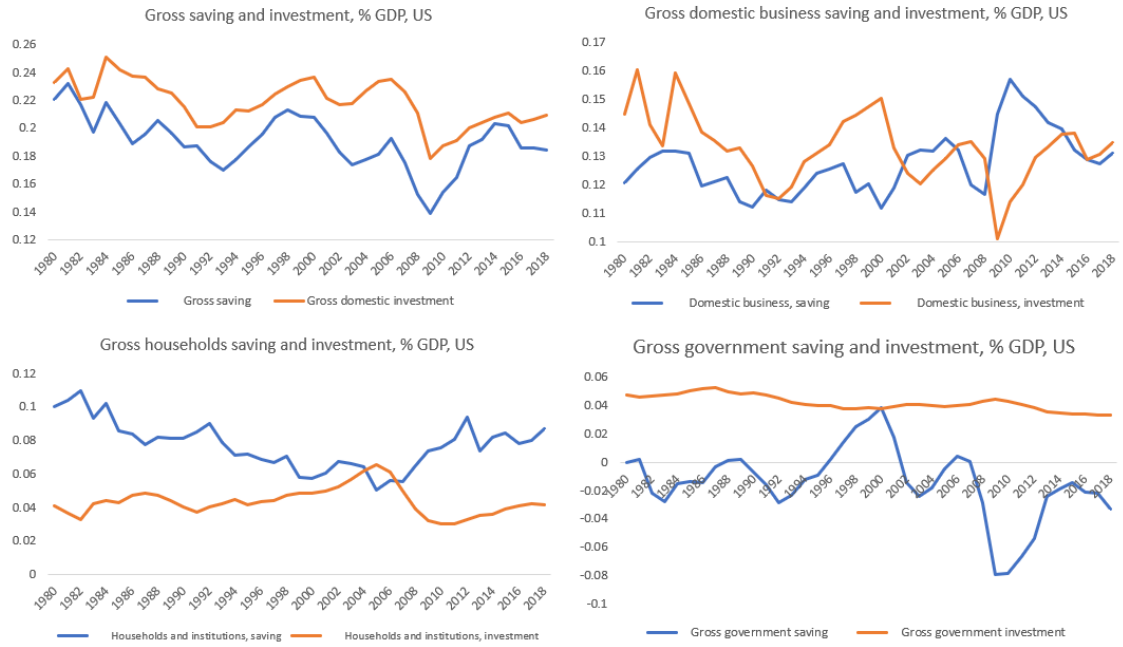
Source: IMF, own calculation

multilateral as a result of structural issues within the US, then even if the Sino-American current account were to become fully balanced, the US would still remain on the deficit side overall, and there would be one or more new surplus countries to replace China. In fact, this is what has happened in recent years. Germany overtook China and became the largest surplus country in the world after 2016, while the US continued to dominate the deficit side. Therefore, this review looks at the US' deficit and China's surplus separately.

The CAB deficit is financed through changes in net foreign assets. The fear of a sudden stop in capital inflows was the primary concern in the US before the financial crisis. Fig. 2.12 suggests that the US gross saving-investment gap has widened since the early 2000s. The increasing external liabilities of the US may be due to the decline in the domestic savings rate since the early 2000s. The government sector was in surplus between 1998 and 2001 and moved into a deficit position by 2002, while the household savings rate has fallen continuously since the 1980s. During the

same period, the investment rate in the US has stayed relatively stable, bouncing back reasonably quickly after the dot-com bubble. Caballero et al. (2008) focused on the increasing foreign demand for US assets, with the associated capital inflows seen as a combined result of both decent growth and a reliable supply of safe financial assets in a country with strong institutions and political stability. Blanchard et al. (2005) identified two primary forces behind the US deficits: firstly, an increase in domestic demand for imported products, which may have originated from the income and credit creation due to the relaxed lending standard in the US banking system (Dullien et al., 2010); secondly, an increase in foreign demand for US assets. As Gourinchas et al. (2010) pointed out, the US has an 'exorbitant privilege' as the banker to the world. After the Asian financial crisis in 1997, the rest of the world saw the US as a safe and liquid haven, and investments, mainly in bank deposits and treasury bills, rose accordingly. The liberalisation of the global financial markets also offered the opportunity for US investors to enjoy higher returns from equity investments and FDI in emerging markets.

Figure 2.12.: Gross Saving and Gross Domestic Investment, % of US GDP



Sources: BEA data, own calculation

In contrast, as one of the most influential hypotheses, the Global Savings Glut (GSG) hypothesis argues that the primary drivers of global imbalances are external

to the US economy and cannot, therefore, be influenced by American policymakers, if placing their focus solely on the domestic economy. The hypothesis was first proposed by Ben Bernanke in his Sandridge Lecture in Virginia in 2005. He argued that the rising US current account deficit and relatively low long-term real interest rates around the world were the results of a significant increase in the global supply of savings (i.e., a global savings glut). This supply was mainly coming from emerging market economies in Asia, especially China, and oil exporters such as Saudi Arabia (Bernanke, 2005).

A GSG can occur due to a range of different factors. King (2011) listed three possible and inter-related reasons to interpret the savings glut in emerging economies. Firstly, many of these economies have adopted an export-led growth strategy, aiming to boost economic growth and domestic employment, and thus reinforce political stability. China, along with other emerging Asian countries, deliberately undervalued its currency and pegged it to the US dollar to boost its export performance. As a result, the foreign reserves of these countries grew substantially because of their trade surpluses. The surplus of savings, as reflected in their current account positions, are intermediated through the supposedly superior US financial sector, with only a fraction of those savings re-exported in the form of FDI. The rapid growth that these economies have seen is partially supported by the more efficient use of such savings (Dooley et. al., 2004; 2007). Secondly, the Asian financial crisis in the late 1990s reduced subsequent domestic investments in these countries. Also, for precautionary purposes, many emerging economies deliberately kept sizeable current account resources to hedge against future risks of capital flight and devaluation (Bernanke, 2009; Wolf, 2014). These reserves became a significant source of capital inflow into the US' official sector, and the purchased Treasury bonds were used as collateral for FDI. Thirdly, constraints on financial movements contributed to the GSG through a variety of channels. Caballero (2006) argued that there was a shortage of safe financial assets worldwide after the 1997 financial crisis in Asia. Song et al. (2011) claimed that, due to financial repression in China, a greater number of productive private firms were forced to rely on retained earnings to finance future investment, while Mendoza et al. (2009) found that higher financial risks at home led many emerging-market investors to prefer safe assets in advanced economies. Chamon and Prasad (2010), meanwhile, focused on how the inadequate provision of public services, such as social safety nets, healthcare and education services, encouraged the accumulation of precautionary savings. Moreover, ageing populations

in Asia and Europe (Bernanke, 2005) and the rise in commodity prices (Yueh, 2013) may have also contributed to the global imbalances.

In addition, Kregel (2008) argued that the global production chain has fundamentally changed since the 1980s. After the profits crisis of the 1980s, the US manufacturing sector gradually shifted its production overseas (especially China). International capital flows became increasingly important in the global economy, which coincided with a sharp decline in tariffs, as more and more developing countries integrated into the global trade system after the Uruguay Round. Semi-finished products and intermediate inputs have gained significant shares in trade. The production chain is no longer vertically integrated and clustered in a few developed countries. Multinational corporate, predominantly the US companies, dispersed the production process across the globe based on various factors such as local labour costs and transport costs.

Fischer (2018) added that, since the early 2000s, foreign-funded enterprises (FFEs) quickly became dominant in the Chinese export portfolio. Up to 2011, exports from the FFEs accounted for over 84 per cent of the trade surplus in merchandise. When a US company (e.g. Apple and Walmart) makes a purchase order to its subcontractor in China, there is no service export recorded on the US side, but the finished product, iPhone in this case, appears to be a goods export in the Chinese trade account. The considerable margin between the export price and market sales price in the US contributes mostly to the growing profits of US-based multinational companies. There is a close association between China's trade surplus against the US and the profitability of US companies. After the GFC, both the share of FFEs exports and China's current surplus as a percentage of GDP fell sharply due to the weak global demand.

2.3.2. Global savings glut (GSG) and the GFC

> "My conclusion was that a global excess of desired saving over desired investment, emanating in large part from China and other Asian emerging market economies and oil producers like Saudi Arabia, was a major reason for low global interest rates. I argued that the flow of global saving into the United States helped to explain the ... persistently low longer-term interest rates in the mid-2000's while the Fed was raising short-term rates. Strong capital inflows also pushed up the value of the

> dollar and helped create the very large US trade deficit of the time, nearly 6 percent of US gross domestic product in 2006. The diversion of 6 percent of domestic demand to imports provides an alternative explanation ... for the failure of the US economy to overheat in the early 2000's, despite the presence of a growing bubble in housing" (Bernanke, 2015)

After clarifying the link between the GSG hypothesis and the global imbalances that existed before the financial crisis, this section further explores that link as the crisis unfolded in 2008. Section 2.2.3 summarises four causes that are commonly found across various episodes of systemic financial crises. Credit bubbles are at the top of the list of the ten essential causes of such crises. The FCIC (2011) concluded that the accumulated savings in trade surplus countries mostly flowed into the US and Europe, which significantly lowered the cost of borrowing in those regions. An extended period of low borrowing costs for risky investments may have misguided investors about the actual level of risk and eventually led to the emergence of a bubble mentality. As a result, the price of risky assets increased dramatically.

The analytical framework for the GSG hypothesis rests on the classical theory of interest or real analysis, which deals only with the long run and when the economy is in equilibrium. There is some confusion in the literature over the use of terminology. Many economists, such as Mankiw (2015), refer to the loanable funds theory (LFT) as the classical theory of interest. However, some early literature, such as Ohlin (1937) and Hansen (1951), made a distinction between the two. The origins of the LFT can be traced back to Knut Wicksell and the Stockholm School. The Stockholm school LFT explicitly points out that the interest rate does not equalise planned savings and planned investment due to the presence of the monetary system (banks and the central bank) in the short run. For instance, in addition to saving, one must take banking credits into account for investment financing, which is compatible with the monetary analysis proposed by the critiques of the classical theory. The monetary system can affect the pricing of credit and the level of commodity prices through the relative positions of the market rate with reference to the natural rate of interest, which is essentially a real rate[25] (Rogers, 1989). However, in the long run, the LFT coincides with the classical theory of interest as there is a market-clearing

[25]Under the assumption of full employment, if monetary rate is below the natural rate, then the price level will rise due to higher demand for resources. Conversely, if the monetary rate is above the natural rate, the price level will fall.

natural rate of interest which is determined by the real factors, such as changes in technology and labour supply. The loanable funds market can only be considered as cleared, when there are no further changes in the balance sheet of the banking sector[26].

To avoid confusion, in this review we have used the classical theory of interest or real analysis, instead of the loanable fund theory, as the name of the analytical framework that underpins the GSG hypothesis. In real analysis, the market for investments and savings is no different from any other goods market. There is a standard commodity (e.g. corn) in the economy, which provides both consumption goods and investment goods. The production of this commodity is either consumed or saved. The saved commodities will then be used for investment purposes. Money is no different from any other commodity and has a completely neutral role in the economy. The natural interest rate acts as the equilibrating 'price', which balances the planned savings and investment[27]. The global economy reaches its equilibrium when planned saving equals planned investment. Graphically, this can be illustrated as in Fig. 2.13. .

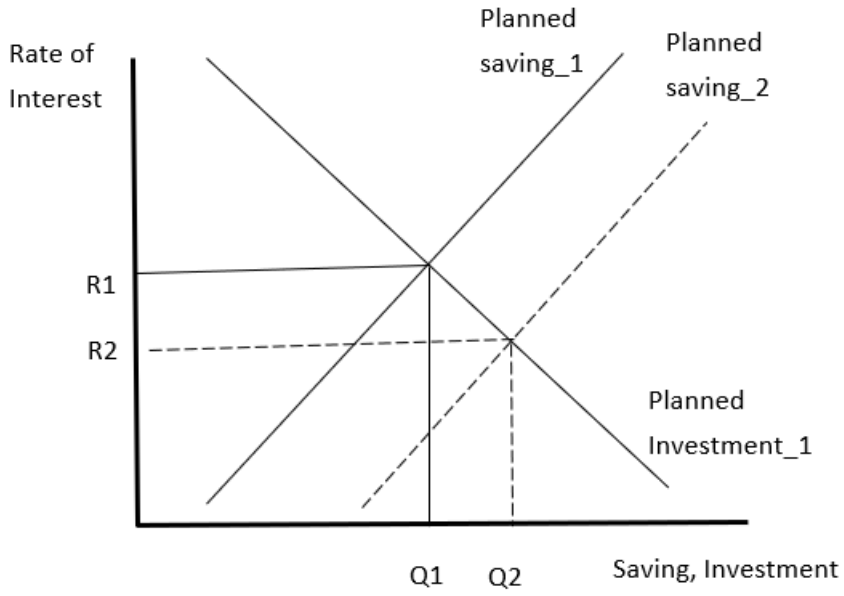
Unlike actual saving and actual investment, which are always equal when taking the world economy as a closed economy, planned saving and investment are ex-ante concepts that may differ. Preference shocks can lead to a higher propensity to save (invest), which shifts the planned saving (investment) schedule to the right and vice versa. When global planned saving exceeds planned investment, as suggested by the GSG, the natural interest rate will fall in order to discourage savings and encourage higher investment to bring the two back into equilibrium. Under the Wicksellian framework, however, the initial excess of planned saving, in the short run, is reflected by a surplus of loanable funds and the market rate remains above the market clearing (natural rate) level. Thus, with less demand for financing from the banking system, the price of credit (market rate) shall fall and converge to the new level of natural rate in the long run. In effect, had the GSG hypothesis followed the Wichksellian framework, then one must recognise that the excessive savings from China can only lower the interest rate in the US with the help of the international banking system.

If one is applying the GSG framework to an open economy, then the ex-post savings

[26]The operation of the banking system during the post-gold standard period is drastically different from Wicksell's account. Under the fiat money framework, most of the money supply is created through bank loans and credits. See sec. 2.4 for a detailed discussion.

[27]Some literature has used desired savings and desired investment.

Figure 2.13.: Demand and supply of loanable funds



Source: created by the author

and investment can be different as well. As shown in equation (2.4), this difference is reflected in the current account balance. Therefore, when planned savings fall short of planned investment in the US domestic market, the economy has a current account deficit. Under the real analysis framework, the flow of saving surpluses from China to the US can be described as the Chinese central bank mobilising domestic saving (through bond issuance) and then injecting these savings into the US economy by acquiring US Treasury securities and other assets. This theory is only possible when there is a standard commodity that can be used globally as described in real analysis. The standard commodity, such as corn, that is left unconsumed or saved in China, can also be used in the US for investment purposes (Bofinger and Ries, 2017).

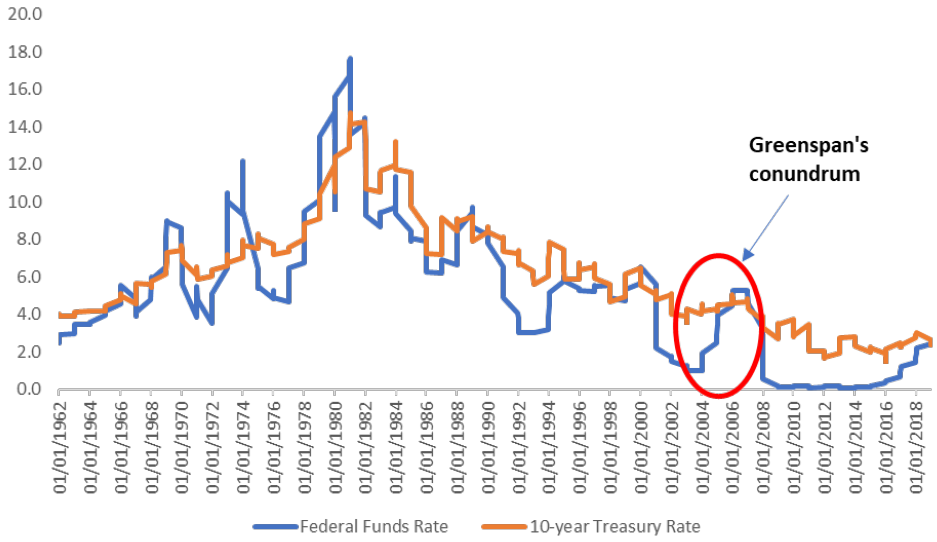
Bernanke (2009; 2011) has asserted that the GSG was the fundamental cause of the current episode of global imbalances, which consequently led to the GFC[28], through both quantity effects and price effects. Flows of savings from countries where they are abundant to where they are deficient are like water seeking its level (quantity effects). The US was attractive for foreign investment not only because

[28]See also Krugman (2009) and Obstfeld and Rogoff (2009).

of technological innovations and rising productivity in the private sector but also because US Treasury securities were regarded by investors as one of the safest and most liquid assets in the world. Moreover, after the 1997 Asian financial crisis, there was a reduction in borrowing in emerging market economies and an increasing desire to accumulate foreign reserves, which contributed to the savings glut at some level.

Another claim of the GSG hypothesis is that the inflow of excess worldwide savings to the US helps to explain Greenspan's Conundrum. In other words, it can explain why the yields of 10-year Treasury bonds did not respond to the Federal Reserve's increase of the Fed funds rate by 150-basis-point in 2005 (see Fig. 2.14). This argument fundamentally shifts the blame to the external forces. The mispricing of risk, due to the steady decline in long-term interest rates, contributed significantly to the formation of credit and asset bubbles, reduced risk premia and caused a deterioration in the quality of credit in the advanced economies. The capital inflows also had secondary price effects through the exchange rate mechanism, because they exerted appreciation pressure on the US dollar, which further worsened the US current account position.

Figure 2.14.: US long-term and short-term interest rates



Sources: FRED and own calculation

Taylor (2009; 2018), on the other hand, argued that cheap credit alone cannot explain the increase in risky investment behaviour in 2002-06. It was the low monetary policy rates that Taylor holds responsible for the housing boom. Had the Fed followed the Taylor rule, the boom and bust cycle would have been much smaller.

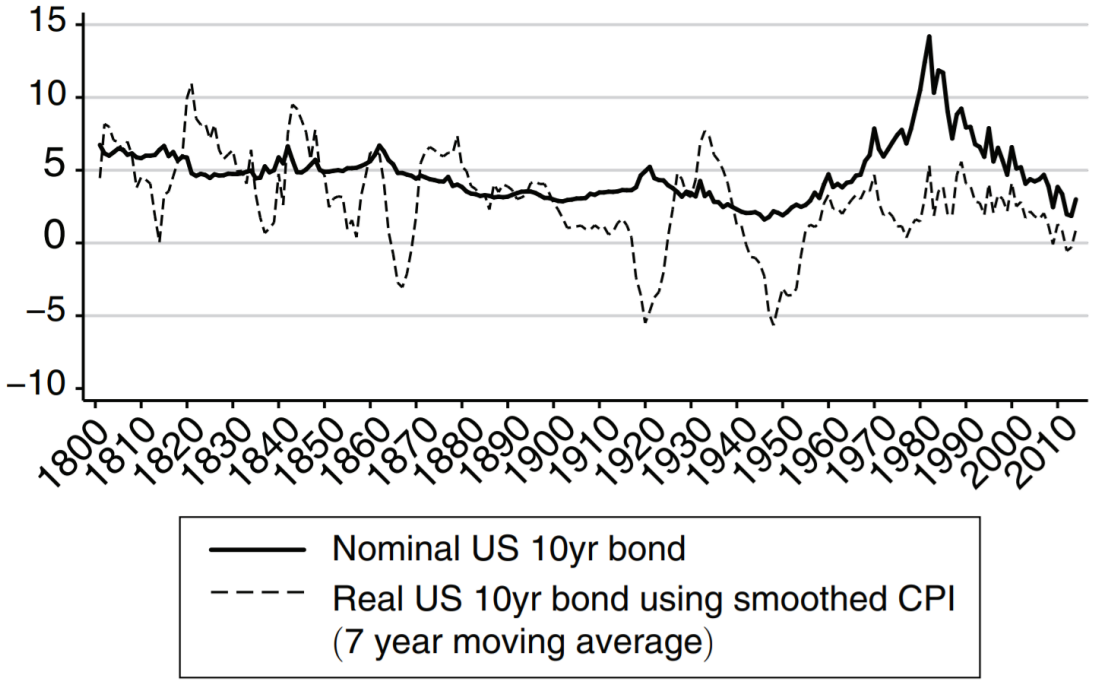
It was the late action of the Fed, in his opinion, that caused the housing bubble. However, Bernanke (2013) rejected this argument using three pieces of evidence. Firstly, the housing boom and bust cycle has weak linkage with domestic monetary policy. There were other vital drivers behind the boom and bust in housing prices. The dynamics of housing prices show very diverse patterns, even when they share the same policy rate. For instance, monetary policy rates were the same across the Eurozone countries, but housing market performances in Germany and Spain were utterly different. There was a huge housing boom in the Spanish market but not in Germany[29]. Secondly, although historical data suggests that there is a negative statistical relationship between interest rates and house prices, changes in interest rates and mortgage rates cannot explain the degree of housing price upswings in the US in the early 2000s. Thirdly, Shiller (2005) considered the beginning of the housing bubble to be in 1997 or 1998, which does not match the timing of the policy rate cuts after the 2001 recession. It was irrational exuberance in the market as well as changes in external sector policies in emerging market economies after the 1997 Asian financial crisis that pushed up housing prices in the US, according to Bernanke (2013). The historical data (See Fig. 2.14) indeed confirms the standard yield curve structure[30] and the close correlation between the short rates and long rates. However, as with housing prices, there are other factors that can affect the dynamics of long-term interest rates, since there have been several periods that presented an inverse yield curve structure. Eichengreen (2015) argued that the 'low' level of long-term interest rates observed in Greenspan's Conundrum was relative to the 1980s. This view is problematic because interest rates in the 1980s were abnormally high, and were outliers in the historical trend. The decline in long rates should be regarded as a reversion back to the long-run mean (see Fig. 2.15).

Using the real analysis framework, Bean et al. (2015) concluded that the downward trend in long-term interest rates around the world prior to the financial crisis was mainly due to the increasing propensity to save, and that the declining propensity to invest may have played a significant role in the post-crisis period. Between 1985 and 2013, global real interest rates declined from more than 4 per cent to nearly zero. They claimed that structural shifts in global demographic features, such as

[29]Other factors, such as the home ownership rate, may be responsible for such difference. While Spain has one of the highest home ownership rate (80.6 per cent in 2008) in Europe, the German market is very rental heavy.

[30]Under normal circumstances, a yield curve is typically upward sloping, with the rate of return positively correlated with maturity.

Figure 2.15.: US nominal and real 10-year bond yield, 1800-2015



Source: Eichengreen (2015)

longevity and lower fertility, as well as the integration of China into the global financial markets ran parallel with the observations of falling global real interest rates and increasing savings rates before the crisis. However, what we observe are ex-post variables, since the accounting identity shows that ex-post saving is always equal to ex-post investment. To verify this theory, one needs to quantify the ex-ante saving and investment, as well as the natural interest rate. These are not readily observable.

According to Arora et al. (2015), the US 10-year bond yields are a good representative of the world's unobserved natural interest rates[31]. Rachel and Smith (2015) provided a quantitative account for the shifts in saving and investment schedules. Since the 1980s, global real long-term interest rates have declined by approximately 450 basis points (bp). On the planned saving side, demographic forces account for one-sixth of the fall, while rising income inequality within countries[32] and the sav-

[31] An actual real rate is equal to the natural rate when it coincides with a zero output gap and zero inflation. (Barksy et al., 2014)

[32] Saving patterns are quite different between the rich and the poor. The rich tend to save much more than the poor. See Carroll (1998) for a theoretical explanation.

ings glut in emerging markets account for a fall of 45bps and 25bps respectively. As regards planned investment, there were also three factors at play. The most important driver was the widening of the spread between the deposit rate and the lending rate (70bps) across the world, thus discouraging desired investments. Rowthorn (1999) showed that the empirically estimated elasticity of substitution between capital and labour appeared to be less than one in most countries. It implied that the observed decline in the relative price of capital goods could not generate enough increase in investment volumes to counter the falling price effects, as it is not easy to substitute labour with capital goods. As a result, there was a shift of the income distribution in favour of labour. It further shifted the desired investment schedule to the left. There has also been a paradigm shift away from public investment since the 1980s, which accounted for a decline of 20bps. In addition to the shifts in the planned saving and investment schedules, poor trend growth prospects, especially in the post-crisis periods, was mainly responsible for the rest of the decline in global real long-term interest rates.

However, several claims of the GSG hypothesis become questionable after a closer inspection of the international capital flow data. Gross international capital flows[33] expanded much more rapidly than the increase in net flows in the run-up to the crisis. Both financial outflows from US residents and inward financial flows from foreigners grew substantially. Therefore, regardless of the US current account position[34], there would have been a tremendous amount of overseas capital flowing into the US financial markets. In evaluating the financial fragility and overall credit conditions, Rey (2015) supported the idea that gross flows should be tracked so that the balance sheets of the financial sector and the households sector can be better monitored. This would also enable the identification of two significant risks that can lead to financial instability — a currency mismatch and a maturity mismatch.

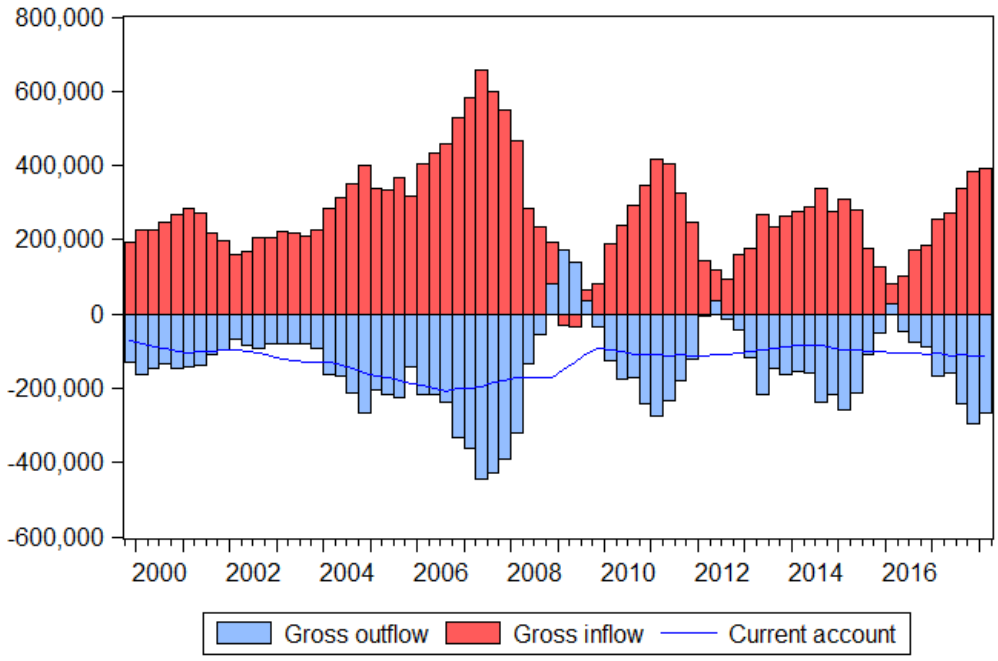
An origins break-down of the capital inflows into the US by global region before the crisis shows that Europe accounted for the lion's share of the total inflows, far exceeding those from China, other emerging Asian economies and the oil exporters (See Fig. 2.16 and Fig. 2.17). Although the advanced countries' share of world trade was declining continuously, capital flows between the advanced economies continued

[33]Gross capital flows refer to the gross capital inflows and gross capital outflows. The former records the total acquisition of domestic assets by foreigners, while the latter is the total purchase of foreign assets by domestic residents.

[34]According to the Balance of Payment statistics, the current account position reflects net capital flows, that is, the difference between gross capital inflows and gross capital outflows.

to account for most of the expansion in gross flows between 1998 and 2007 (Lane & Milesi-Ferretti, 2008). Similarly, a tremendous level of gross outflows from the US to Europe was observed. Shin (2012) described how US dollar liquidity was channelled through European banks into the global economic system in the run-up to the crisis. A significant amount of dollar funds was raised by foreign bank branches in the US and transferred to offshore markets. As shown by Broner et al. (2013) and Bluedorn et al. (2013), the reduction in gross capital flows during the crisis was substantially higher than the decrease in net capital inflows. This was mainly due to retrenchment inflows between the advanced economies. The continuous gross inflows from China and Japan acted more like a stabiliser.

Figure 2.16.: Gross capital inflows and outflow and current account balance, US, 2003 - 2018

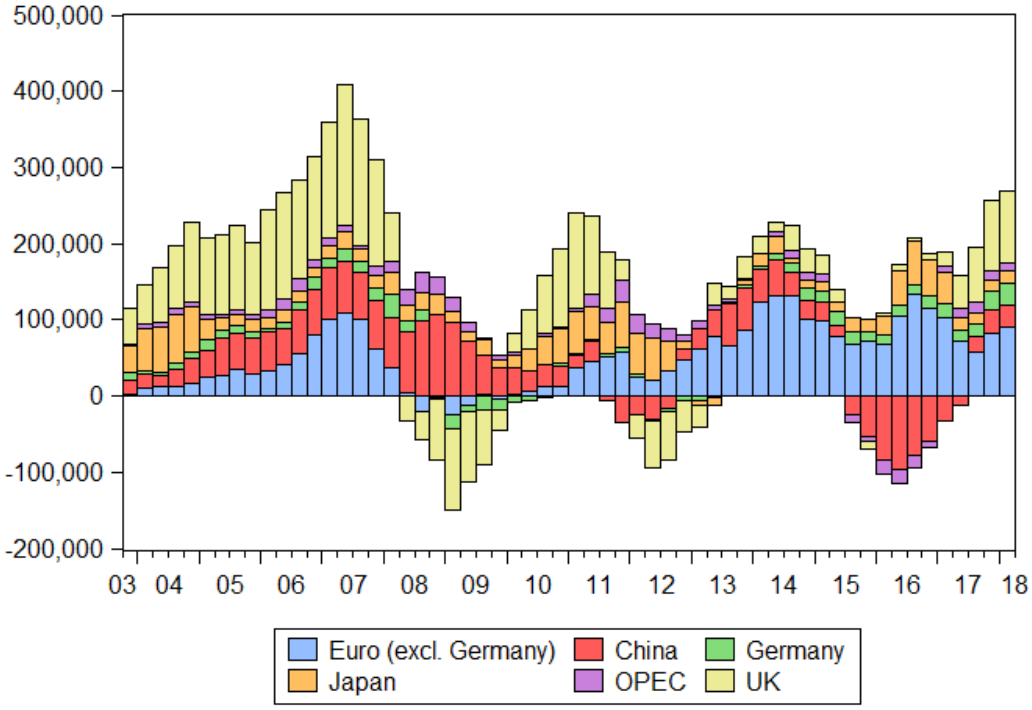


Source: BEA, created by the author

While the GSG hypothesis argues that the capital inflows (in fact, net capital flows) mostly came from the accumulated reserves from surplus countries for the purchase of US Treasury securities, much of the gross inflows into the United States went to the private sector and was in the form of non-government securities[35]. The US

[35]See Fig. 3.11 for the foreign holdings of the US long-term securities.

Figure 2.17.: Gross inflows by regions, US, 2003 - 2018

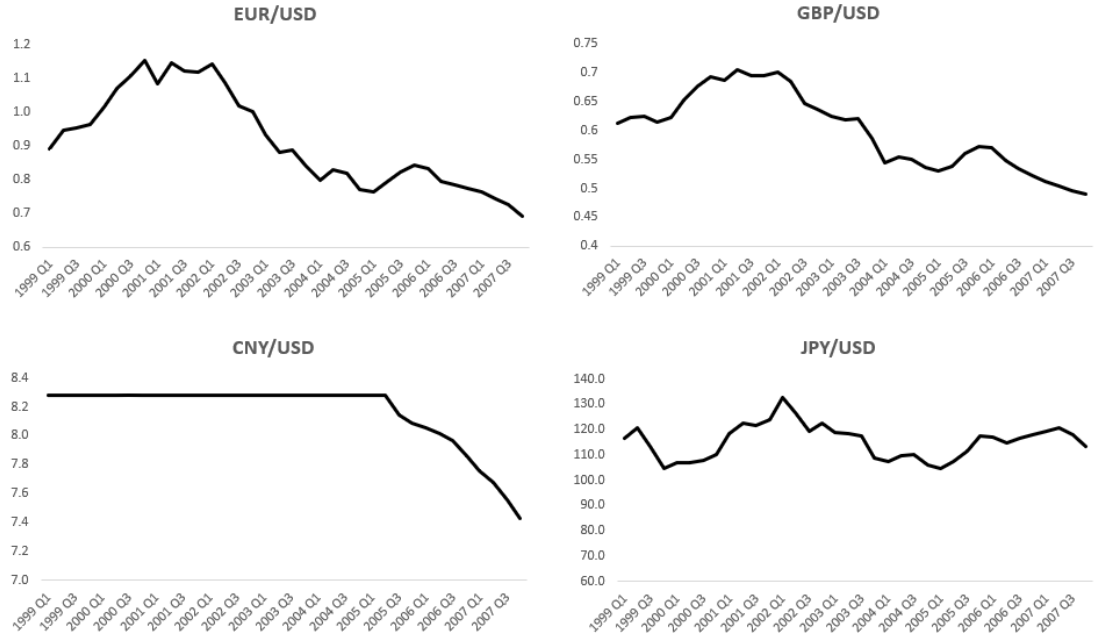


Source: BEA and author's calculations

securities that were purchased by foreign investors and the ever-growing liabilities of US banks towards overseas residents from the early 2000s onwards are strong signals that the US was at the epicentre of the global credit bubble. As documented by Lane and Milesi-Ferretti (2009), while China and Japan held majority of the US government debt securities prior to the crisis, the holders of private sector debt securities, especially mortgage-backed securities, were mostly advanced economies and offshore financial centres.

Also, there is little evidence to support the GSG hypothesis regarding the impact of the dollar exchange rate on the US current account position. The hypothesis argues that capital inflows from surplus countries put appreciation pressure on the US dollar, which further worsens the US current account deficits before the GFC. However, as shown in Fig. 2.18, the US dollar continuously depreciated against the other major currencies of the world between 2000 and 2007, but no signs of improvement were evident in its current account position. Avdjiev et al. (2016) argued that the analytical framework gave insufficient weight to the role of the US dollar

Figure 2.18.: Exchange rates between major currencies and US dollar



Source: FRED and author's calculations

as a funding currency that denominates the majority of the debt contracts globally. A lot of dollar-debts are originated in off-shore markets, not the US. Many firms, especially in emerging markets, accumulated a large share of liabilities denominated in dollars through their overseas subsidiaries, while holding financial assets in domestic currencies. The weakening of the US dollar thus becomes self-reinforcing, as an initial depreciation would improve their credit-worthiness and enable the banking sector to lend more.

Similarly, in line with the textbook model, the GSG hypothesis expects current account deficits to shrink through currency depreciation. However, since the beginning of the GFC, contrary to conventional wisdom, the US dollar has strengthened sharply while the current account deficit was narrowing. The appreciation of dollar can be attributed to the tightening of dollar-denominated credits after the GFC. The situation is exacerbated by the currency mismatch observed in the corporate sector balance sheets of many economies, such as South Korea. Dollar appreciation reduces the credit-worthiness of the firms and leads to further tightening in credit-supply conditions globally.

Since the GFC, an increasing trend of deleveraging by financial market participants

outside the US, such as European banks, has also been observed. As the financial crash severely eroded the values of risky US mortgage bonds, institutions that invested heavily in these bonds found themselves to be over-leveraged. Their investments were predominantly financed through short-term funding channels, such as foreign exchange swaps (McCauley and McGuire, 2009). The maturity mismatches between long-term dollar assets and short-term dollar debts forced these foreign banks to bid aggressively for US dollars to repay their dollar-dominated debts, which eventually pushed up the dollar's value. Krugman (2007) failed to acknowledge the importance of the US dollar's role as an international funding currency and predicted that the value of the dollar would depreciate drastically as investors collectively rushed to sell the currency.

Bofinger and Ries (2017) further pointed out that an excess of global desired savings over desired investment implies that the ex-post expenditure falls short of the expectation of the producers. Therefore, one would expect to see inventories to build up, which results in weak growth performance to bring the economy back to equilibrium. However, during the GSG period, the world economy recorded the fastest economic growth of the last four decades (See Fig. 2.19) so there must be some other key drivers that are not captured by the GSG hypothesis.

Before we turn to alternative theories for explanations, it would be useful to review the literature on economic history to find out whether global trade imbalances in the past had any correlations with financial crises. Section 2.3.3 mainly focuses on case studies[36].

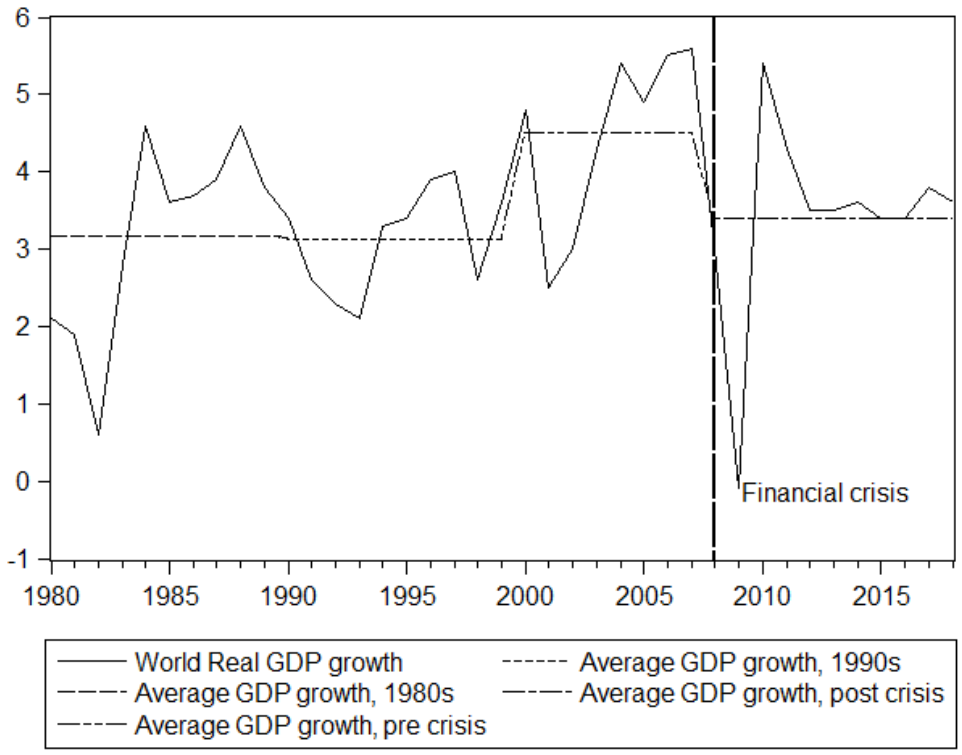
2.3.3. Global imbalances in the past

> "And by the lowest reckoning India, China and the Arabian peninsula take from our empire 100 million sesterces[37] every year - that is the sum that our luxuries and our women cost us" - Pliny the Elder (Rackham and Jones, 1975)

The global imbalance is not a new phenomenon. It can be traced back to the beginning of international economic relations although the consequences of each episode vary given the different historical and macroeconomic backgrounds. Considering its history, a balanced global economy may only exist in theory.

[36]Chapter 3 includes a brief review of the empirical analysis in the economic history literature.
[37]Ancient Roman coins that are made of silver

Figure 2.19.: World GDP growth, 1980-2018



Source: IMF and author's calculations

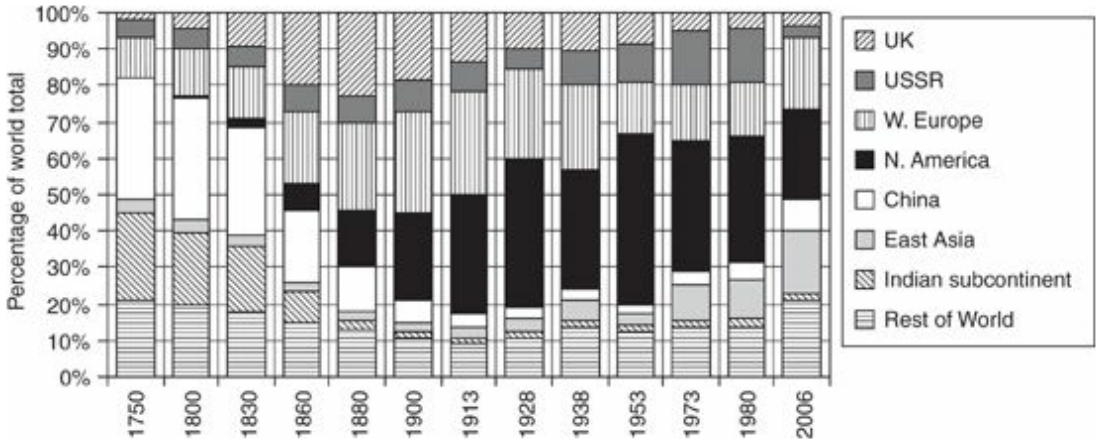
In the first century CE, Pliny the Elder's Natural History recorded one of the earliest global imbalances. The Roman author and naval commander criticised that the Romans' expensive tastes had led to a large number of luxury imports from the East such as silks, precious stones, perfumes and spices. There was a great deal of debate over the validity of Pliny's figure, however, the finding from the document fragment Muziris Papyrus in the Austrian National Library provides a direct monetary account of the scale of trade between the Mediterranean region and India. A ship named 'Hermapollon' traded between an Egyptian port and Muziris on the South-western coast of India. One side of the document records a loan contract between a rich ship-owner and a merchant for a mission to acquire previous goods from the far East; the other side provides details on the weights and the value of the Indian cargo loaded at Muziris (Galli, 2017). One of the calculated shipments was worth 6,911,852 sesterces (before tax HS 9,215,803). According to the writing of the Greek geographer - Strabo, by 27 or 26 BCE, the number of ships sailing from the port

of Myos Hormos on the Red Sea to the Indian coasts has already increased to 120 per year (Wilson, 2015). The loss of specie was about 1 percent of Roman GDP, estimated to be around HS10 billion, which appeared to be sustainable (Fitzpatrick, 2011).

The Roman Empire ended in the late fifth century and the rise of Islam followed soon after. For the next thousand years, the trade routes that connect Eurasia were segmented by the Arabs and Persians as they controlled major choke points of the silk routes on both land and sea. During this period, trade imbalances were relatively less persistent. In contrast, China alternated between deficit and surplus positions throughout different dynasties (Cinar et al., 2015).

The Renaissance led to a resurgence of Europe and the age of discovery. Mercantilism was particularly influential in pre-Smithian economics. The desire to accumulate precious metals and more lucrative prospects to trade with the far East directly was supported by many European monarchs. The Voyages to bypass the Muslim merchants fundamentally changed both trade patterns and the world. (Allen, 2011) Columbus's discovery of the New World later became a steady source of raw materials such as silver for Europe. Vasco da Gama's trips to India helped the Portuguese monopolise the Indian ocean. The enormous profits persuaded the Dutch and British to join the Eurasian maritime trade later.

Figure 2.20.: Distribution of world manufacturing



Source: Allen (2011)

The industrial revolution caused a drastic re-structuring of the world economy. While Western Europe was experiencing dramatic economic growth due to indus-

trialisation, countries such as China and India went through an extensive period of deindustrialisation (see Fig. 2.20). Although the monopolistic status of the British and Dutch East India Company trading with the Far East allowed some merchants to earn supernormal profits back home, these European countries continued to run a persistent trade deficit against the Far East like the Romans did. According to Frank (1998), since the fifteenth century China has held persistent, significant surplus positions against the rest of the world for more than 250 years, which was supported by most of the silver produced in the Americas and Japan.

The import demand for tea, silk, and porcelain remained strong, but Britain struggled to export much to China apart from precious metals. The rising productivity in the manufacturing sector in Europe, coupled with falling freight rates, significantly lowered the price of manufactured goods. The manufacturers desperately needed the overseas markets to achieve economies of scale to average out the initial high fixed costs.

In 1793, George Macartney assembled a delegation to visit China in the hopes of persuading the Qianlong Emperor to open up trade with Britain, but the immediate outcome was not encouraging. In Qianlong's letter to King George III, he wrote:

> "Our Celestial Empire possesses all things in prolific abundance and lacks no product within its borders. There is therefore no need to import the manufactures of outside barbarians in exchange for our own produce."

China's resistance to open up for trade[38] led to two dramatic measures in an attempt to reduce trade deficits. First, in order to reduce the reliance on importing tea from China, the British began the import substitution strategy by experimenting with tea plantations in the Indian subcontinent. This proved to be highly successful. Tab. 2.1 shows that the share of tea exports from India grew from merely 0.2 per cent in 1850 to 12 per cent in the early twentieth century. The second method was more disturbing: the opium trade. British merchants grew opium in the Indian sub-continent and proceeded to sell it to China to pay for its imports. Following the defeat of the two subsequent opium wars, China was forced to open up for trade and retreated into a trade deficit position (Keller et al., 2010).

India, as another surplus player and the world's former manufacturing powerhouse,

[38] According to Keller et al. (2010), in the18th Century, China's engagement in foreign trade was limited to Canton port only. The restriction on international trade was due to the government's belief that potential risks of opening up trade might cause domestic disorders, which outweighed any potential benefits.

was systematically deindustrialised through various unjust industrial policies imposed by the British. Textile imports from India were discriminated with high tariffs, while the British goods enjoyed much lower duties. At the same time, importing machinery into India was prohibited so that new industrial techniques could not be used (Nehru, 2008). Although India's trade surplus position remained[39], the colonial rules had effectively downgraded the subcontinent to an agrarian economy that specialised in exporting raw materials. Unemployment and poverty were widespread (Pal, 2014).

Table 2.1.: Composition of India's exports, selected commodity

Years	Raw Cotton	Cotton goods	Raw jute	Manufactured Jute Goods	Indigo	Opium	Hides and Skins	Tea	Seeds	Sugar	Food-grains
1850-1	19.1	3.7	1.1	0.9	10.9	30.1	1.8	0.2	1.9	10.0	4.1
1860-1	22.3	2.4	1.2	1.1	5.7	30.9	2.0	0.5	5.4	3.1	10.2
1870-1	35.2	2.5	4.7	0.6	5.8	19.5	3.7	2.1	6.4	0.0	8.1
1880-1	17.8	4.2	5.2	1.5	4.8	18.2	5.0	4.2	8.6	0.0	17.1
1890-1	16.5	9.5	7.6	2.5	3.1	9.2	4.7	5.5	9.3	0.0	19.5
1900-1	9.4	6.4	10.1	7.3	2.0	8.8	10.7	9.0	8.3	0.0	13.1
1910-1	17.2	6.0	7.4	8.1	0.2	6.1	6.2	5.9	12.0	0.0	18.4
1920-1	17.4	7.6	6.8	22.1	0.0	0.0	3.5	5.1	7.0	0.0	10.7
1930-1	21.0	1.6	5.8	14.5	0.0	0.0	5.3	10.7	8.1	0.0	13.5
1935-6	21.0	1.3	8.5	14.5	0.0	0.0	0.0	12.3	0.0	0.0	0.0

Source:Pal (2014)

Trade imbalances were not unique to Eurasia. They also existed in the trans-Atlantic trade. Between 1870 and 1914, massive capital flows from Europe went to finance long-term projects such as infrastructure construction and budget deficits in the rapidly developing New World. Due to information asymmetry and potential agency problems, much of the capitals flowed to the New World countries in the form of portfolio investment instead of Foreign Direct Investment (FDI). The imbalances adjusted smoothly through the price-specie-flow mechanism without resulting in a crisis. The stable gold standard and institutional assurance under the rule of the British Empire may have also contributed at some level as a stabilising force (Bordo et al., 1998).

In contrast, De Cecco (2012) argued how the global imbalances between Britain

[39]The British government started issuing special Council Bills for anyone who wanted to trade with India. These bills can only be acquired using precious metals. Therefore, the golds and silvers that would have ended up in India now kept in London. According to the calculation of Chakrabarti and Patnaik (2017), the total wealth being 'stolen' from India was estimated around US$45 trillion.

and the US after the First World War (WWI) might have led to a much more disastrous result: the Great Depression. WWI exhausted most of the British capital accumulated overseas during the pre-war period in exchange for war-time imports and Britain gradually built up debts against the US government. At the end of the war, the US became the new economic powerhouse in the world, and its current account was in surplus. Britain, on the other hand, turned into a net debtor to the rest of the world from a surplus position. In the 1920s, the dominance of sterling as the primary world currency was weakened; both gold and dollars were favoured as reserve currencies. However, Britain still wanted to maintain its leadership role in the world economic order and keep the British pound as the dominant international currency. The British government restored the gold standard and unrealistically set it back to the pre–WWI parity. The post-war price level was still substantially higher, despite some decline years after 1918. To maintain the peg between the overvalued currency and gold, the Bank of England faced a tremendous amount of pressure from speculative attacks. It had to rely on a tight monetary policy to defend its gold reserves, which consequently led Britain into an economic recession.

Table 2.2.: Gold reserves of central banks and government, 1913-1935 (percentage of total)

Country	*1913*	*1918*	*1923*	*1924*	*1925*	*1926*	*1927*	*1928*	*1929*	*1930*	*1931*	*1932*	*1933*	*1934*	*1935*
United States	26.6	39.0	44.4	45.7	44.4	44.3	41.6	37.4	37.8	38.7	35.9	34.0	33.6	37.8	45.1
England	3.4	7.7	8.6	8.3	7.8	7.9	7.7	7.5	6.9	6.6	5.2	4.9	7.8	7.3	7.3
France	14.0	9.8	8.2	7.9	7.9	7.7	10.0	12.5	15.8	19.2	23.9	27.3	25.3	25.0	19.6
Germany	5.7	7.9	1.3	2.0	3.2	4.7	4.7	6.5	5.3	4.8	2.1	1.6	0.8	0.1	0.1
Argentina	5.3	4.5	5.4	4.9	5.0	4.9	5.5	6.0	4.2	3.8	2.2	2.1	2.0	1.9	2.0
Australia	0.5	1.5	1.5	1.5	1.8	1.2	1.1	1.1	0.9	0.7	0.5	0.4	[a]	[a]	[a]
Belgium	1.0	0.7	0.6	0.6	0.6	0.9	1.0	1.3	1.6	1.7	3.1	3.0	3.2	2.7	2.7
Brazil	1.9	0.4	0.6	0.6	0.6	0.6	1.1	1.5	1.5	0.1	n.a.	n.a.	0.1[b]	0.1[b]	0.1
Canada	2.4	1.9	1.5	1.7	1.7	1.7	1.6	1.1	0.8	1.0	0.7	0.7	0.6	0.6	0.8
India	2.5	0.9	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.4	1.4	1.4	1.3	1.2
Italy	5.5	3.0	2.5	2.5	2.5	2.4	2.5	2.7	2.7	2.6	2.6	2.6	3.1	2.4	1.6
Japan	1.3	3.3	7.0	6.5	6.4	6.1	5.7	5.4	5.3	3.8	2.1	1.8	1.8	1.8	1.9
Netherlands	1.2	4.2	2.7	2.3	2.0	1.8	1.7	1.7	1.7	1.6	3.2	3.5	3.1	2.6	2.0
Russia-USSR	16.2	—	0.5	0.8	1.0	0.9	1.0	0.9	1.4	2.3	2.9	3.1	3.5	3.4	3.7
Spain	1.9	6.3	5.6	5.5	5.5	5.4	5.2	4.9	4.8	4.3	3.8	3.6	3.6	3.4	3.3
Switzerland	0.7	1.2	1.2	1.1	1.0	1.0	1.0	1.0	1.1	1.3	4.0	4.0	3.2	2.9	2.0
All other	9.9	7.8	7.1	6.9	7.4	7.3	7.4	7.3	7.0	6.3	6.4	6.0	6.9	6.7	6.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Hardy (1936)
a. Less than 0.05 of 1 per cent
b. Bolivia, Brazil, Ecuador, and Guatemala

The US, as the main creditor and the largest holder of gold (see Tab. 2.2), was unwilling to lower interest rates to endanger its domestic economy with inflation and massive capital outflows. The US also did not recognise the importance of

providing long term concessionary finance to the deficit countries and failed to make external adjustments to allow domestic price to rise. A global shortage of the dollar supply and the shifting interests of the US investment banks from Europe and Latin America to the home stock market and the housing boom ultimately led to recessions in deficit countries and the rest of the world. The system collapsed with the onset of the Great Depression (Bordo, 2005). Countries that adopted expansionary monetary policies, aiming to stablise domestic economies, were facing pressures from speculative attacks. As a result, they were forced to abandon the gold standard one after one (Eichengreen, 1992). The ideal solution would have required coordinated efforts from all countries involved, however it was much harder to materialise due to vested political and business interests among countries.

The next episode of global imbalance occurred after the Second World War (WWII). This time the 'Dollar Gap' was even higher than the interwar period, but a more effective solution was put into effect. Europe required dollars for imports to revive their war-torn economies but had very little to export to the US as payment. However, this time, the gap was closed by the concessionary bridging finance programmes: the Marshall Plan[40] and the Mutual Security Agreements, which contributed tremendously to the global recovery. If such measures had been in place during the 1920s and 30s, the Great Depression could have been avoided.

After WWII, three defeated countries (Germany, Italy, and Japan), followed the US advice, adopted the export-led strategy and significantly devalued their currencies against the dollar (De Cecco, 1979). Since the 1980s, the US current account has turned into deficits, except for a temporary return to a balanced position in the early 1990s, and never regained its surplus.

The demise of the Bretton Woods was marked by the end of convertibility between the dollar and gold during the Nixon regime. Both domestic and external factors have contributed at some level. The US government was increasingly pressured by the inflationary effects of its policies to finance the Vietnam War and the Great Society programme (Bordo, 2005). At the same time, the dollar faced mounting pressures from speculators to devaluate against the currencies of several surplus

[40]De Cecco (2012) argued that although the US realised that the imbalance between Europe and US themselves during the immediate post-WWII period (1945-1950 to be more specific) was one of the main causes of high unemployment in many European countries, especially in Germany and Italy, the successful implementation of the Marshall Plan was still mainly driven by US political interests. The Soviets' decisive victory in Europe increased US government anxieties about 'losing' Europe to Communism.

countries, including France and Japan. These countries followed the export-led strategy and continued to convert the accumulated dollar claims into gold. Dooley et al. (2004) suggested that like France and Japan under the Bretton Woods system, China and other emerging economies have been deliberately running undervalued peg against the dollar. However, the trend of growing global imbalances did not reverse after the end of Bretton Woods, as both authorities in the surplus and deficit countries shared the 'fear of floating'. The uncertainty of future exchange rates and a large amount of hot money that aim for speculation seemed to be much more of a concern than current account positions. The exchange rate speculation adds more complexity to the analysis of the adjustments in global imbalances. A trade deficit now would not necessarily attract capital inflows to balance the external sector. Instead, massive capital outflows[41] could occur and make the imbalance even worse.

2.4. Alternative hypothesis

A review of the major episodes of global imbalance in the past seems to suggest that there is no direct evidence to link current account imbalances and financial crises. In fact, current accounts are rarely in balance even when free floating exchange rate regime is in place. Some economies, such as the UK, are able to sustain a sizable deficit for decades, while others, such as Thailand in 1997, have experienced severe reversals as a result of a sudden stop of capital inflows (Ghosh and Ramakrishnan, 2012). The economic consequences primarily depend on whether the mismatches between the planned investment and savings are caused by 'natural' factors (e.g., demographic transition and productivity catch-up) or due to reckless fiscal expenditures or private sector consumption booms driven by credit bubbles. This section reviews two alternative theories that challenge the GSG view: the endogenous money creation theory and the global financing glut hypothesis.

The former places the focus on the money creation and generation process within the domestic economy, while the latter argues that trans-Atlantic capital flows prior to the crisis played a more critical role in financing the credit bubbles. The hypothesis that capital flows from surplus countries stimulated credit booms in deficit nations

[41] Again, the outflow is narrowly defined here, which includes outward foreign direct investment, outward portfolio investment, and various other outward investments. Changes in official reserves are excluded.

by keeping long-term interest rates low seems questionable, because current account balance positions cannot reflect the supply and use of funds. Moreover, Borio and Disyatat (2011) argued that market interest rates result from the concerted impact of policy rates, market expectations and risk premia, while the saving–investment framework is best used to determine the natural equilibrium rate in an economy, which cannot be observed in reality.

2.4.1. Endogenous money creation

The world economy can be seen as a single closed economy. In a closed economy, ex-post saving and investment are counterparts of each other, but with the presence of the financial sector, investment is not necessarily financed by saving. In national accounting, saving is the net balance between the GDP at market price and total final consumption expenditure (see Equation (2.6)).

$$S = Y - C - G = I \tag{2.6}$$

Financing, however, is a cash-flow concept. It describes transactions in goods and services with money or credit as a medium, so even when an economy has zero saving, domestic production and its associated expenditures can still be financed through a myriad of funding sources. These funding sources can come from borrowing or credit[42], for example, households can take mortgages to buy a property.

Changes in the value of financial assets and liabilities can be reflected in various combinations of financial flows, which are captured by the 'flow of funds' table in national accounts, and net capital gains. Savings data cannot reveal financing patterns and bears no relationship with such changes. For instance, financial deepening[43] is often observed during the economic development process. With increasingly better access to financial services, such as credits and loans, increases in assets and liabilities are very likely to exceed savings in any given period. The failure to recognise the differences between savings and financing may be due to three misinterpretations in the current analytical framework.

[42]See Disyatat (2011) for a simple example.

[43]Financial deepening refers to the increased provision of financial services within an economy. Broad money supply to GDP ratio is often used as an indicator.

Firstly, the framework of real analysis, used by the GSG hypothesis, suffers from the fallacy of composition[44]. That is, what is valid at the micro-level may not be valid at the macro-level. The gross incomes of an individual agent are either consumed or saved, while the savings are either converted into financial assets or real assets. However, for an economy as a whole, an increase in deposits from one sector is always matched by a decline of the same amount in the deposits account of another sector (Borio and Disyatat, 2011). For example, if the households sector reduces its aggregate consumption and saves more, company turnover will also fall. Changes in gross financial assets and liabilities only occur when there is additional income created through the issuance of financial claims and obligations.

Secondly, the framework assumes that without monetary factors, real investments materialise through the transfer of real resources from saving units—represented by a standard commodity—to investment units. Under real analysis, an investment is 'financed' by the funds that saved by savers. This is essentially a real transfer from savers to investors, which is misleading in practice. In many economics textbooks, banks take deposits from savers, some of which are kept as reserves while the rest are lent out to borrowers. Under perfect competition, the banking sector is merely an intermediary, allocating funds between alternative investment projects. Given that savings are equal to investments, there can be no new investments without additional savings.

The money multiplier theory is another misconception that is widely taught in economics textbooks. The theory suggests that a Central Bank can directly or indirectly manage the money stock (M) in the economy by manipulating the monetary base[45] (H). The money multiplier is given as $\frac{H+M}{H} = 1 + \frac{1}{H/M}$. The Central bank can then manage the money supply using open market operations (OMO). OMO is the policy instrument that influences the monetary base through the buying and selling of government bonds. Although interest-rate targeting is more common today, it is only conceptually different from targeting monetary aggregates. The underlying

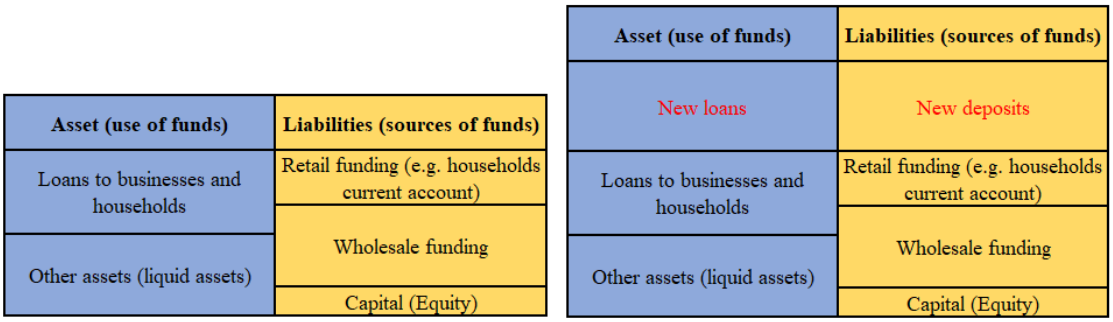
[44]This is a built-in problem for many macroeconomic models using representative agent as micro-foundations, which were widely used before the financial crisis and still remain popular today. Caballero (1992) and Kaplan et al. (2018) recognised this problem, but argued to incorporate more realistic micro-behaviours such as heterogeneous agents. Muellbauer (2016), however, suggested macroeconomic policy models are better represented in a system of equations, which incorporates sectoral balance sheets and structural breaks such as shift in credit conditions in an economy.

[45]It consists of cash held by the public, cash in the bank vaults, and desposit reserves at central bank

mechanism is similar. The Central Bank manages the discount rate and federal funds rate through OMO. When the target rate is lowered, there will be more money supply in the system.

In contrast, the endogenous money creation theory argues that the banking sector has an active role of its own. Banks do not need to attract deposits from savers in order to lend. They can create credit by extending loans to either businesses for production and investment purposes or households for consumption purposes. Investment and consumption can generate saving through financing with money that is created by banks. If the banking sector issues new loans to another sector of the economy, the balance sheets of both sectors expand with additional assets and liabilities. Money can be created in the economy through lending and destroyed through repayments by borrowers (Bofinger and Ries, 2017). For example, in Fig. 2.21, there are two balance sheets of the banking sector. The balance sheet on the left shows the asset/liability positions of the banking sector at time t. On the asset side, there are broadly two categories — liquid assets (e.g., cash and marketable securities) and long-term loans (e.g., household mortgages). The liability side mainly consists of deposits from different sectors and net worth. By issuing new loans, net of repayments, the balance sheets expand and credit money is created. The balance sheet on the right shows the asset/liability position of the banking sector at time $t + 1$. The balance sheet of the Central Bank, however, has no changes.

Figure 2.21.: Money creation through the banking system



Source: created by the author

If money creation is to facilitate a transaction of the existing assets (e.g., mortgages issued for the purchase of an existing property), then it increases the loan-to-GDP ratio in an economy, as the transaction of the existing assets is not counted in GDP, which also exerts inflationary impact on asset prices (Bezemer, 2014). An

asset price boom in turn leads to more demand for such assets and consequently more credit creation. If the expected future growth of house prices continues to exceed income or profits growth, then the demand for housing and credit will end up in an upward spiral. Credit-fuelled price booms are not limited to residential properties but also extend to commercial real estate. Muellbauer and Williams (2011) argued that mortgage credit played an essential role in making sense of the behaviour of house prices and consumption in advanced economies[46]. Financial liberalisation and innovation can affect the real economy through three channels. Firstly, they enable households to smooth consumption inter-temporally between housing and non-housing. Secondly, falling mortgage down-payment constraints increasingly extend coverage towards the younger population, especially first-time buyers. Thirdly, households with existing housing assets can benefit from the capital gains through either mortgage refinancing or equity withdrawals. The limit on money creation through the banking system is discussed in detail in the following paragraphs.

Knut Wicksell is generally acknowledged as one of the first economists to highlight the role of commercial banks in money creation and the potential impact on purchasing power. Turner (2013) summarised Wicksell's ideas into three essential points:

1. Credit is transferable, effectively having the same properties as money;
2. The banking sector can create credit, hence money and purchasing power;
3. Credit can be generated amongst businesses even in the absence of a banking sector. Comparing to a pure-cash economy, business-generated credit also creates greater purchasing power like banking credit.

However, the credit created by banks is different from government fiat money. It is essentially a debt contract, and therefore the cycle of money creation and destruction has significant implications for the stability of the overall economy. Minsky's FIH clearly illustrates how endogenous money creation, if not managed appropriately, can lead to macroeconomic instability. (Minsky, 1986)

Can the banking sector create unlimited money? McLeay et al. (2014) suggested three possible constraints. The first is a market constraint. Due to competition from other banks, an individual bank has to remain profitable and control risks. At

[46]For example, the US in the 1970s, Japan in the 1980s, and South East Asia in the 1990s.

the same time, regulatory bodies also impose certain external limits, such as reserve requirement[47] and capital adequacy ratios[48]. However, in the recent housing boom, the banking sector has been increasingly engaged in the securitisation process. As a result, originator banks no longer need to keep mortgages on their balance sheets and are therefore not constrained by the capital adequacy ratio. With the risks passing to other investors in the market, banks have a greater incentive to expand credit and lower lending standards. Lavoie (2019) pointed out that banks can also lend to non-bank financial institutions (the shadow banking sector) to purchase securitised assets off their balance sheets. Secondly, the behaviour of money holders matters. If lending is used to repay outstanding loans (e.g., refinancing a mortgage), then the newly created money is soon destroyed. This is particularly true when considering short-term credit, such as credit cards. Thirdly, monetary policy can influence the spreads between different interest rates in the economy, and thus manage borrowers' demand. Altavilla et al. (2018) argued that short-term policy interest management may not be as effective as monetary policy authorities believe. The fall in net interest income due to the low interest rate environment can be counterbalanced by gains from loan loss provisions, non-interest income and rising stock prices.

It is essential to realise that with a modern banking system a financial crisis is still possible both in a closed economy and in an open economy with a balanced current account. International capital flows are not necessary conditions for a financial crisis. Keen (2015) illustrated this using the Post-Keynesian sectoral balance approach[49]. Assume there are only two sectors in a closed economy — the private sector (p) and government sector (g). The flow of money must be summed to zero, since the inflow into a sector is an outflow from the other sector.

By the income approach, GDP is given by (2.7),

$$GDP = W + T = C + S + T \tag{2.7}$$

[47]It is normally set by the central bank as a minimum requirement ratio of total deposit liabilities. This policy concept is directly linked to the theory of money multiplier. According to Benes and Kumhof (2012) and McLeay et al. (2014), it is no longer a binding constraint on money supply in reality, as central banks would typically supply the reserves on demand. In fact, some countries, such as the UK and Canada, there is no minimum reserve requirement.

[48]This is a ratio that reflects the relative position between a bank's total capital and its risk-weighted assets.

[49]Wynne Godley used it and successfully predicted the financial crisis in 2008. See Godley (1999) and Godley and Zezza (2006) for a detailed analysis.

where W represents wages and T represents tax revenues. Wages can be further disaggregated into consumption (C) and savings (S). Bringing in (2.1)[50], we get

$$C + S + T = C + I + G \tag{2.8}$$

after rearranging, we get,

$$S - I = G - T \tag{2.9}$$

Equation (2.9) suggests that, in a growing economy, the only plausible and sustainable case is to let the government run deficits. As the economy grows, money aggregates have to expand to meet the demand for money. The government sector runs a surplus[51] implies that tax revenue exceeds government spending. In other words, the money destruction exceeds the money creation by the government sector. As the counterpart of the government sector in the closed economy, the private sector must run a deficit, which means that there is a net outflow of money from the private sector towards the government sector. To satisfy this condition, money must be created in the banking sector. This implies that non-banking sub-sectors (e.g., households and firms) will become increasingly indebted in order to sustain the surplus in the government sector, as well as economic growth. Such a process will lead to the unsustainable build-up of private debt and consequently a financial crisis.

2.4.2. Global financing glut

This section reviews the Global Financing Glut (GFG) hypothesis—proposed by a group of authors such as Borio and Disyatat (2011; 2015) and Avdjiev et al. (2016) in greater detail. The GFG can be seen as an extension of the endogenous money theory since they share the same analytical framework of monetary factors, but the GFG gives a greater focus to the role of international capital flows in the run-up to the GFC.

[50] In a closed economy $X - M = 0$

[51] This was indeed the case with the US government in the early 2000s.

The GSG hypothesis not only fails to explain several stylised facts, it also has significant shortcomings on its analytical side. The saving-investment framework that underlies the GSG hypothesis has little to say about how global economic activities are financed and how market interest rates behave. Under the framework of the GSG, there is no role for money that is endogenously created. Hence, the hypothesis cannot capture the behaviours of the global financial market. The ongoing debates on current account imbalances are diverting attention away from the major causes (i.e., monetary and financial factors) of the crisis.

The difference between saving and financing can be best illustrated using the net and gross capital flows[52] in an open economy. According to the IMF's Balance of Payments (BoP) definition, in an ideal world the sum of the current account, capital account[53](KAB) and financial account (FAB) should be zero. These statistics come from various sources and are always prone to errors, and therefore need a balancing item to absorb the discrepancies (2.10).

$$CAB + KAB + FAB + Balancing\,item = 0 \tag{2.10}$$

In BoP accounts, the current account is equal to gross capital inflow minus gross outflows in the financial account. Therefore, it only captures net capital flows.

By focusing solely on the current account, the evolution of gross flows (especially when cross-border transactions only involve financial assets) and their impact on existing stocks of financial assets/liabilities are overlooked. To better illustrate this point, let us consider a simple example presented by Al-Saffar et al. (2013). From (2.11), we know that the current account balance is identical to the domestic saving-investment gap (Eq. (2.4)). Deficits occur when investments exceed savings, which can be financed by the issuance of either debt (D) or equity (E) or both.

$$CAB = S - I = \Delta D + \Delta E \tag{2.11}$$

[52] In the Balance of Payment statistics, the net amount between residents' purchases and sales of foreign assets is taken as the gross outflow, while gross inflow is equal to the net amount between non-residents' purchases and sales of domestic assets.

[53] This records international capital transfers as well as transactions in non-financial non-produced assets.

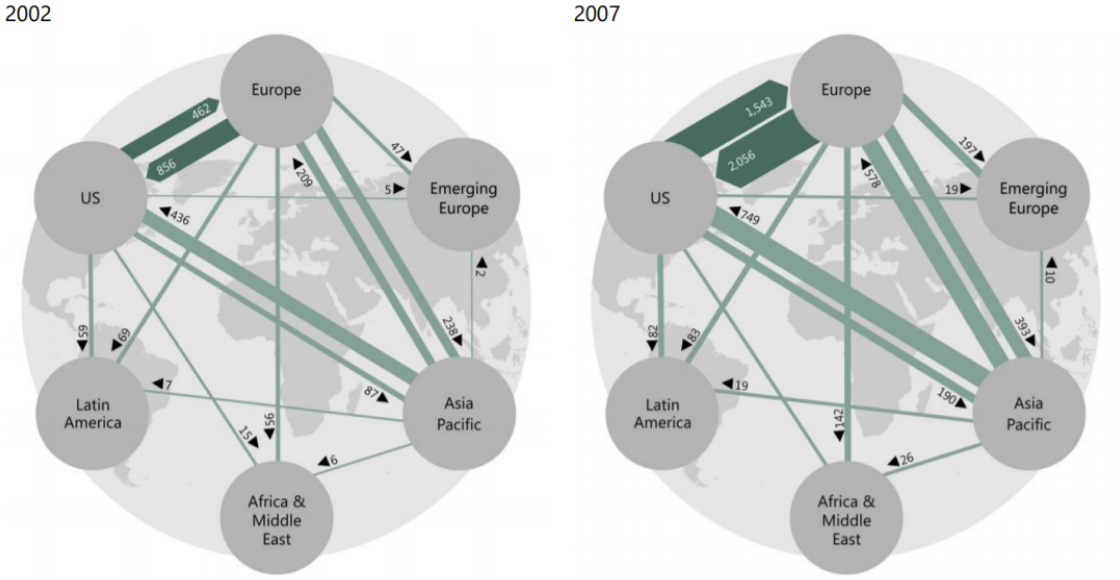
Even a balanced current account does not guarantee that a country is free from large-scale cross-border financial activities. With an open capital market, countries may experience massive gross debt inflows, but the CAB cannot reflect the patterns of such capital flows if the country also engages in massive equity investments abroad. The gross inflows and outflows can offset each other ($\Delta D = -\Delta E$). If domestic projects cannot generate cash flow in time to meet external debt obligations, then the economy will be exposed to rollover risk on its foreign liabilities.

Gross financial flows between the advanced economies expanded rapidly in the run-up to the 2007–09 crisis, as verified by both US BoP statistics (see Fig. 2.17) and the BIS's locational banking statistics (see Fig. 2.22). Although the Eurozone's current account was roughly in balance, it contributed more to gross capital inflows into the US economy than any other region. We can conclude that, on balance, economies with current account deficits (surpluses) draw on (release) resources from (to) the rest of the world. However, deficit economies are not necessarily financed by economies that are running surpluses.

Underlying expenditure for consumption (which determines the level of saving) and investment can be financed in various ways. The sources of funds can be credit creation from the domestic banking sector or international capital flows. Consumption can also be financed from current income and a reduction in assets. The current account neither reveals whether a domestic investment is financed from abroad, nor to what extent. For example, a US firm that imports Chinese goods can transfer its US dollar deposits held in a UK bank to the Chinese firm. Although the UK was not part of the trade transaction, the increased US current account deficit is matched by a fall in its residents' assets vis-a-vis the UK, while the increased Chinese surplus is reflected by a decline in UK residents' assets vis-a-vis China. Current account positions only reflect where the production and consumption have taken place, whereas gross capital flows indicate where the financing is sourced and used.

Lindner (2015) provided a detailed account of international financial transactions between Europe and the US. As the primary reserve currency, overseas demand for the US dollar is immense. Other countries can acquire US dollars only in two ways. The first is through international trade. Surplus countries accumulate dollar reserves when exporters receive the currency as a means of payment from US importers. The US counterpart can pay for its imports, through its bank, using its existing stock of deposits or newly created credit money. The second channel is the US money

Figure 2.22.: Gross capital flows among major regions, 2002 and 2007



Source: Avdjiev et al. (2016)

markets. US dollars can be raised either through borrowing or from selling other financial assets.

Most European countries run nearly balanced current accounts (or in some cases deficits) against the US. Therefore, the massive gross capital flows between the US and Europe are mainly through the second channel. A typical financial transaction prior to the financial crisis was a two-step process (see Tab. 2.3). In the first step, European banks would sell some Euro-denominated short-term liquid financial assets, such as asset-backed commercial papers (ABCPs)[54] to US mutual funds in the money markets in exchange for their US dollars. This type of transaction is essentially an asset swap. Although the overall size of the balance sheets would not change, the composition of assets for the US mutual funds and European banks would change. On the liability side, the dollars raised by the European banks would increase US liabilities vis-a-vis Europe. In the second step, the European banks' dollar holdings would then be used to purchase CDOs from US investment banks. These investment banks would use the dollars to acquire more and more securitised mortgages off the balance sheets of the US banking sector.

The entire process would have no overall impact on the current account, since the liability position between the US and Europe would be restored, despite liabilities

[54]These are essentially a short-term money market security.

Table 2.3.: Balance sheet positions with capital flows between the US and Europe

1. Money market mutual fund (MMMF) buys an ABCP from a European bank

	US			**Europe**	
	MMMF	investment bank	aggregate economy	bank	aggregate economy
Means of payment	$-\Delta m_{\$}$			$+\Delta m_{\$}$	$+\Delta m_{\$}$
Other financial assets	$+\Delta ofa_{ABCP}$		$+\Delta ofa_{ABCP}$		
liabilities			$+\Delta l_{\$}$	$+\Delta l_{ABCP}$	$+\Delta l_{ABCP}$

2. European bank buys a CDO from a US investment bank

	MMMF	investment bank	aggregate economy	bank	aggregate economy
Means of payment		$+\Delta m_{\$}$		$-\Delta m_{\$}$	$-\Delta m_{\$}$
Other financial assets				$+\Delta ofa_{CDO}$	$+\Delta ofa_{CDO}$
liabilities		$+\Delta l_{CDO}$	$+\Delta l_{CDO} - \Delta m_{\$}$		

Source: Lindner (2015)

and assets changing hands between different players within the two economies. However, the mismatch of different maturities played a critical role in the financial crisis. The maturity for ABCPs is no more than 270 days, but mortgages can have maturities lasting decades. When the housing bubble in the US eventually burst, money markets lost confidence in ABCPs, which in turn led to refinancing difficulties for European banks.

This framework is in line with empirical observations. Avdjiev et al. (2016) rightly pointed out that it was European banks that first felt the pain at the beginning of the financial crisis, not Chinese banks. These round-trip transactions between the US and Europe were one of the crucial sources of funding prior to the crisis. These capital flows had a relatively small impact on current account positions since the outflows to Europe were mostly channelled back to the US at a later stage.

Obstfeld (2012) presented two scenarios in which current accounts may not matter in the analysis of international capital flows. The first scenario is highly idealistic. Capital movements are entirely free from any friction and restrictions. Therefore, countries can diversify away all their idiosyncratic, country-specific risks by investing globally. For example, countries can freely trade shares in each other's securities markets. Net asset trades, as recorded by the current account position, reflect the wealth transfers between countries. Perfect international financial markets would enable countries to be fully insured, and therefore wealth transfers would no longer exist. The recent high-speed growth in gross asset flows has made the real world a better approximation of this imaginary world.

In contrast to perfect capital movements, his second scenario focused on rapid two-way asset trading, which reflects regulatory arbitrage, tax avoidance and distorted

incentives more generally. Countries that build up significant currency and maturity mismatches are exposed to huge risks, which may not be accurately reflected in the net transactions recorded by the current account. For example, most US financial institutions appeared to be doing well on a flow basis in the years leading up to the financial crisis. The income statements of these institutions showed that they were making record profits. However, if their balance sheets had been scrutinised more carefully, they would have revealed substantial risk exposures. This paradox means that at the country level, just looking at current account balances can be highly misleading. Compared to a country's balance sheet, the current account is relatively unimportant.

Obstfeld was more supportive of the second scenario. However, he did not agree that the growing importance of two-way asset trading made the current account irrelevant. Current account positions are vitally important because they signal wealth transfers and serve as a vehicle by which world demand gets reallocated between countries. Policymakers and regulators have to pay more attention to financial factors (e.g., national balance sheets and the flow of funds) if they are to be able to spot future financial risks.

Avdjiev et al. (2016) further identified a broader set of limitations in the prevailing models used to analyse the global financial system. They argued that the current analytical framework relies on a triple coincidence: a GDP area, decision-making units[55], and a currency area[56]. Such a framework is over-simplified and overlooks the importance of financial flows. The widely used representative agent approach in macroeconomic models obscures the differences between decision-making units at the macro-level. For example, Korea's current account was in a surplus position before the 2008 crisis, and its net external asset position appeared to be positive against the rest of the world. An appreciating dollar, it was supposed, would benefit the country.

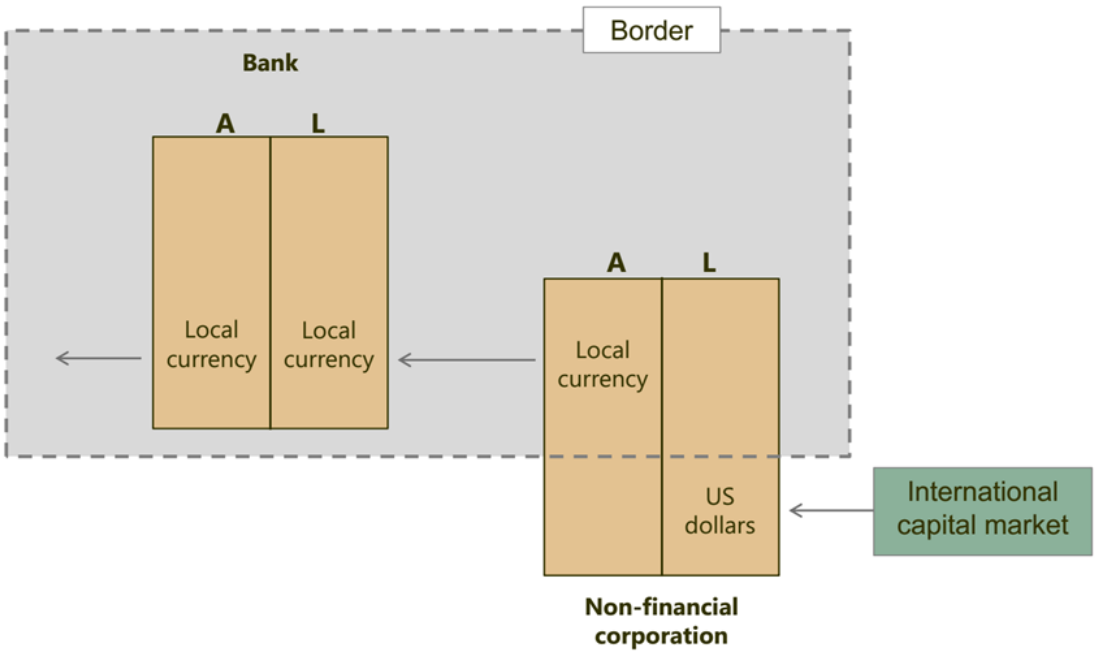
Nevertheless, the Korean economy was severely damaged by the crisis. The positive net external asset position at the aggregate level obscured the fact that the Korean corporate sector accumulated substantial amounts of dollar-debts. As Korea's growth engine, the losses in the corporate sector considerably due to the appre-

[55] All sectors (firms, households, government) in the economy are summed into one representative decision-maker.

[56] Each economy or currency union has its own currency, and the use of that currency is largely confined to areas under its jurisdiction.

ciation of the US dollars completely outweighed the net gains from the positive investment position of the government sector (see Fig. 2.23). Borio and Disyatat (2015) also pointed out that the prevailing models in international finance (i.e., the inter-temporal approach[57]) have significant deficiencies. Based on the households' consumption-smoothing decisions and firms' inter-temporal maximisation of expected profits, the current account balance is effectively the vehicle for transferring savings and investments. Such models also overlook the role of banks in endogenously creating purchasing power and financing. Therefore, inter-temporal models are ill-suited for promoting the understanding and forecasting of financial crises.

Figure 2.23.: The Korean case



Source:Avdjiev et al. (2016)

Bofinger and Ries (2017) added an alternative monetary framework based on the flow of funds. The 'flow of funds' table records the supply and use of funds. Hence, financing is clearly distinguished from saving. Apart from making saving deposits, the sources of funds can be from bank loans, the issuance of government bonds or stock market equities. Funds can end up financing new investment, buying an existing real asset or financing the government deficits.

With a recognition of the importance of monetary analysis and the failings of real

[57]See Obstfeld and Rogoff (1996) for examples

analysis in understanding financial crises, it becomes clearer why the GSG and GFG hypotheses were formed. The GSG emphasises the capital inflows from current account surplus countries. However, without acquiring US dollars in the first place, the Chinese central bank, for example, would not be able to mobilise domestic saving and invest in the US. These inflows from surplus countries rely on the willingness of those countries to continue investing their dollar reserves, gained through foreign trade, in long-term US treasury bonds (the official sector).

In contrast, the GFG stresses the importance of capital inflows from Europe. These inflows rely on the ability of European banks to raise short-term liquidity from the US money markets and provide financing for the mortgage-backed securities market (the private sector). Under the real analysis framework, high Chinese savings are exogenous to US domestic economic policies, but the GFG framework suggests otherwise. In the run-up to the crisis, the high level of Chinese savings was due to the US consumers' high propensity to consume. Over-consumption in the US was the result of the housing boom, domestic credit creation and loose monetary policy from the Fed, with the trans-Atlantic capital flows accelerating credit creation in the US. In models that feature endogenous money creation, the same exogenous shock can cause a much larger disturbance in bank lending and can have a more significant impact on the real economy. (Jakab and Kumhof, 2015)

Using the GFG analytical framework, Borio and Disyatat (2015) further challenged two of the most enduring puzzles in international finance: the Lucas paradox and the Feldstein-Horioka puzzle. The classical theory claims that in a world with perfect capital mobility, rational agents will invest in countries that offer the highest marginal returns on capital. Therefore, the savings of any country will flow to countries that offer the most productive investment opportunities, and this flow will gradually equalise marginal returns on capital across countries. However, Lucas (1990) observed that the scale of capital flows from capital-rich developed countries to capital-scarce developing countries was minimal, despite the effects of diminishing returns on capital in economies with abundant capital. The current episode of imbalances presents an even more interesting pattern, with a massive amount of capital flowing from developing countries to advanced countries (IMF, 2015). In a similar vein, Feldstein and Horioka (1979) argued that if the classical theory is correct and capital moves freely, a low correlation between domestic investment and savings should be observed, because greater domestic savings will always seek higher returns on investment, which may not necessarily be domestic. However,

their empirical findings suggested otherwise.

Once the limitations of current accounts analysis are acknowledged, both puzzles disappear. Despite current account surpluses in capital-scarce developing countries, investments may still be financed from abroad, given the higher potential yields for foreign investors. Hence, the Lucas paradox may not hold. Similarly, an economy that engages actively in international capital movements, such as the Eurozone prior to the GFC, may still run a balanced current account. A high correlation between domestic saving and investment does not necessarily mean that there are minor capital movements either. Therefore, the Feldstein-Horioka puzzle also disappears.

2.4.3. Discussion on long-term interest rates

The data of gross capital flows and endogenous money theory demonstrate convincingly that surplus countries such as China had limited contributions in direct financing the US private sector credit boom. Capital inflows from China mostly ended up in the official sector, not the private sector. However, to fully reject the GSG hypothesis, one also needs to break the assumed linkage between the high demand of US treasury securities from surplus countries and the persistent decline of US long-term real interest rates. The GSG hypothesis explains the movements of interest rates through the saving-investment framework in classical economics underpinned by purely real factors, which is better at describing the Wicksellian natural rate of interest - an equilibrium concept[58].

Borio and Disyatat (2011) argued that what we observed were long-term market rates. They are the result of the interplay among monetary factors such as the policy rates, expected inflation and future policy rates, and the term premium. These factors will impact on the portfolio choice of financial asset holders in the economy and the risk perceptions and preferences of investors. When all the markets (e.g. credit and goods market, and labour market) in the economy are in equilibrium, the market rate can coincide with the natural rate, and there are no inflationary pressures. The two rates can differ when there is a disequilibrium in the market. When the market rate is lower than the natural rate, the excessive investment demand has to be financed by the creation of credits. As the endogenous money theory suggests, the banking system is not always constrained by savings or banks' reserves at the

[58] According to classical economics, prices are flexible enough to bring all markets, including labour market, back to equilibrium.

Central Bank. In fact, credits create deposits. In a pure credit economy, there are hardly any auto-stabilisers to bring the market rate back to the natural rate. Wicksell argued that the deviation between the two rates was a result of capital market failure due to lack of incentive and information.

The GSG hypothesis is only valid if the market rates trend towards the natural rate over the relevant observation period, but the natural rate is an unobservable theoretical construct (see Barksy et al. (2014)). According to Wicksell, the discrepancy between the market rate and natural rate, hence the relative movement of the natural rate, is reflected by the level of inflation in an economy. If the market rate is below (above) the natural rate, then the price level will rise (fall). The price level will tend to stabilise when the two rates are converging. Although based on the different underlying mechanisms, both Wicksellians and the New Keynesian models, rely on nominal rigidity, and take inflation as the signal that there is a deviation between the two rates (Woodford, 2011). Therefore, during the Great Moderation[59], when inflation remained low and stable[60], the GSG view could be regarded as valid. However, the unsustainable expansion in credit and asset prices prior to the crisis seems to suggest that the market rate is significantly and persistently below the natural rate. The New Keynesian models predict inflation to rise under such unsustainable asset booms, which is contrary to what was observed, and partly explains why most economists failed to foresee the crash. According to Hayek (1933), it is not general consumer price inflation, but relative price distortion that is a signal for the deviation of two rates. The Central Banks was misled by inflation targeting models and failed to raise the interest rates when it was below the equilibrium level, which ultimately contributed to the financial turmoil in the US.

On the contrary, Post-Keynesian (PK) economists such as Pilkington (2014) or Bofinger and Ries (2017) either suggest the natural rate takes multiple values instead of one equilibrium rate or reject the concept of the natural rate altogether (see Lavoie (2014)). Market interest rates are not directly influenced by the real factors as proposed in the GSG framework, which echoes Keynes's view that interest rates are the results of the interplay between the relative demand and supply of money stocks. According to Keynesian liquidity preference theory, a higher level of income

[59]It refers to the period between the mid-1980s and the outbreak of the recent financial crash in 2008 as the Great Moderation. During this period, the volatility of business cycle fluctuations of the world economy was mild, economy and employment grew with inflation tamed at a relatively low levels.

[60]This implies that the output gaps also remained low

increases the demand for liquidity. With a vertical money supply curve, a rise in income will lead to an increase in interest rate, which results in an upward-sloping LM curve. The Horizontalists[61] argue that central banks set a policy target rate rather than the stock of money. The money supply expands when the income level rises. Therefore, the LM curve is horizontal, not vertical. Lavoie (2014) added that the horizontalism is no longer a distinct feature of Post-Keynesian analyses. The horizontalists mainly rejected the monetarists' vertical (exogenous) money supply, and the concept is widely accepted by New-Keynesian economists such as Romer (2000). However, the debate shifted from money supply to the existence of a single equilibrium natural rate to serve as the policy target for full employment and price stability, which is an implicit assumption of the Taylor Rule.

Keynes (1936) argued that, instead of having only one unique natural rate of interest at the full employment level with zero output gap, for every level of employment, there is a 'natural' rate of interest to ensure the system is in equilibrium. In Chapter 17, he wrote,

> "...for every rate of interest there is a level of employment for which that rate is the 'natural rate', in the sense that the system will be in equilibrium with that rate of interest and that level of employment. Thus it was a mistake to speak of the natural rate of interest or to suggest that the above definition would yield a unique value for the rate of interest irrespective of the level of employment. I had not then understood that, in certain conditions, the system could be in equilibrium with less than full employment. I am now no longer of the opinion that the concept of a 'natural' rate of interest, which previously seemed to me a most promising idea, has anything very useful or significant to contribute to our analysis. It is merely the rate of interest which will preserve the status quo..."

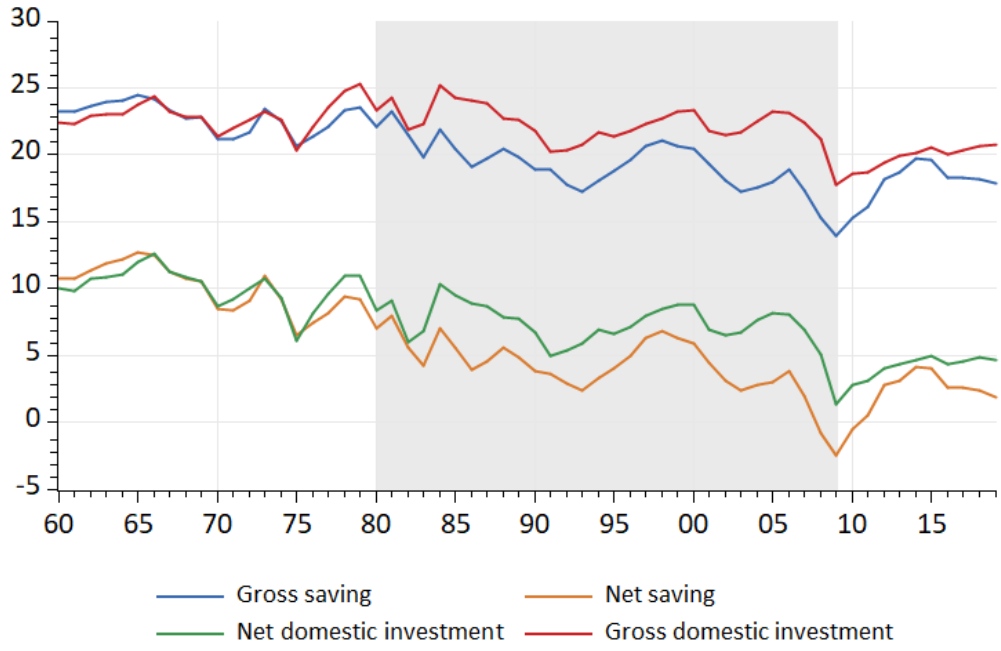
According to Pilkington (2014), the level of employment is in turn determined by the level of investment. In Chapter 11, Keynes (1936) used marginal efficiency of capital for investment decisions to distinguish from the marginal returns. While the former

[61] Moore (1988) coined the term to describe a group of economists who believe that the credits are supplied on demand, hence both the supply curves for bank reserves and credits are horizontal at a given rate. Unlike the money multiplier theory, reserve requirements place no constraint over the money creation by the banking sector. This view is supported by BoE economists such as McLeay et al. (2014).

is a subjective judgment[62], the latter requires rational mathematical calculations. Bofinger and Ries (2017) thus suggested that the IS/LM-AS/AD framework is fully compatible with Keynes's propositions of multiple values, that is, for each given level of income and employment, there is an equilibrium level of (natural) rate of interest at the intersection between the IS and LM curves. Hamilton et al. (2016) provided empirical supports to the multiple values view.

If one rejects the mainstream view on natural rate of interest, then the GSG's claim on the excessive savings caused the persistent low level of long-term interest rate does not hold any more. The PK theory of interest rate suggests that the long-term interest rates are fundamentally determined by the policy rate set by the Fed and real economy must adjust to the policy-determined interest rate environment than vice versa.

Figure 2.24.: The dynamics of gross investment rate versus net investment rate



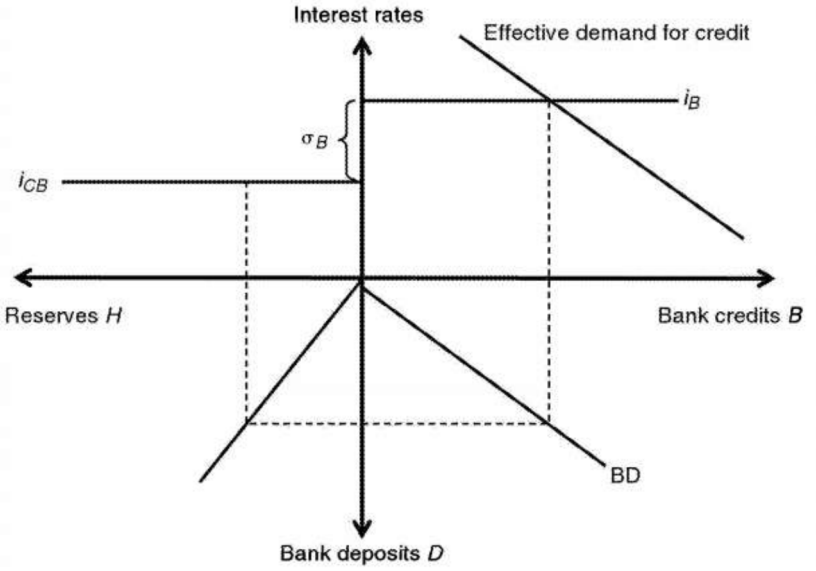
Source: BEA data, created by the author

Moreover, under the monetary framework, savings are created/determined by investment demand. A fall in long-term interest rates is more likely to reflect the falling

[62]It depends on whether the expected rate of return exceeds the rate of interest offered by potentially the safest assets. It is better known as the animal spirits.

propensity to invest[63] and consequently, a downward shift of the IS-curve. A steady declining trend for both the net investment rate and saving rate since the 1980s was observed in all G7 countries (see Fig. 2.24 for an US example). This downward trend was offset by an increasing trend in the emerging markets, but the world as a whole has witnessed a relatively stable saving rate. It contradicts the GSG claim that the increasing propensity to save is the root cause of the persistent low global interest rate. To have a falling net investment rate and increasing propensity to save at the same time, there must be an extreme decline in the propensity to invest.

Figure 2.25.: Post-Keynesian theory of interest rates and endogenous money



Source: Lavoie (2014)

Lavoie (2014) provided a complete framework to accommodate the PK theory of interest rates and the endogenous money theory. In Fig. 2.25, the central bank has the autonomy to set the policy rate at i_{CB}. The policy rate serves as the base rate in the economy. The market rate (i_B) is derived by adding a mark-up (σ_B), which reflects both market expectations and term premium, to the base rate[64]. According to the endogenous money theory, credits can be supplied on demand at any given level of the market rate. Therefore, the level of bank credits is essentially driven by the effective demand for credit. Bank lending creates deposits, but the amount

[63]This led to lower level of income and saving.
[64]This is consistent with Borio and Disyatat (2011) and Bernanke (2015)

of bank deposits depends on the liquidity preference of the public and the spread between the deposit rate and market rate, which reflected by the slope of the BD curve. In the lower-left quadrant, some of the bank deposits are kept as a reserve at the Central Bank either due to the regulatory requirement or precautionary purpose. The policy rate has little impacts on the amount of bank reserves in the central bank. This view is fully consistent with McLeay et al. (2014) at the Bank of England.

2.5. Conclusion

Understanding the underlying causes of the GFC is vitally important. Financial crises can result in severe and prolonged economic recessions that impose tremendous socioeconomic costs on society. In the increasingly globalised world of today, the economic prosperity of every country is inevitably dependent on a healthy and sustainable global economy. Incorrect theories and cause–effect analyses can lead policies astray. Moreover, anti-globalisation movements have been on the rise in recent years, and President Trump has ascribed the US domestic imbalances and income inequality to the actions of foreign partners rather than to a host of complex factors .

Given that global economic imbalances have been identified as one of the main causes of the GFC, re-balancing the global economy has been seen as a top priority for the global economic reform agenda. The GSG hypothesis, proposed by Ben Bernanke, is one of the most influential theories in this regard, and attempts to explain the global imbalances and how they are linked to the GFC.

After a thorough review of the GSG hypothesis, we find that its critical claims are not consistent with some of the facts that were observed before the GFC. Theoretically speaking, global imbalances can indeed pose threats to the sustainability of the global economy, but no clear evidence exists to suggest that there was a strong link between such imbalances and the GFC. From a historical perspective, it can be seen that previous episodes of global imbalances did not necessarily result in financial crashes (19th century America being a good example). The US and many advanced economies went through decades of financial liberalisation after the end of Bretton Woods. This significantly changed the nature of international capital flows across the Atlantic. Before the GFC, massive gross capital flows were observed. Certain economists, such as Borio and Disyatat (2011) and Shin (2012) therefore came up

with the GFG hypothesis to counter the GSG hypothesis. Proponents of the global imbalances argument focus solely on the current account imbalances of the period, which reflects the scale of net capital flows. However, patterns within those gross capital flows are not given enough attention. Unlike the trans-Pacific inflows into the US, which mainly went into purchasing Treasury bonds, most of the trans-Atlantic capital flows resulted in the purchase of private-sector/corporate bonds, which were at the epicentre of the GFC. Therefore, to understand the GFC, one has to shift the research focus away from net capital flows and towards gross capital flows.

On the theoretical side, the endogenous money theory challenges the underlying analytical framework of the GSG hypothesis, i.e., real analysis. The banking sector plays an important role in money creation in a modern capitalist economy. Once the concepts of saving and financing are made clear, the GSG argument no longer provides a feasible justification to its claims that it was the excessive savings from surplus countries that fuelled the credit and asset bubbles in the US before the GFC. Thus, according to the EM and GFG hypotheses, the international banking sector is the missing link in understanding the GFC.

However, in order to entirely reject the GSG argument, one needs to investigate the indirect effect of trans-Pacific capital flows on the US credit and asset boom through the downward pressure on long-term interest rates. A review of the theoretical debates reveals a further weakness in the framework of real analysis and its reliance on the concept of a natural rate of interest. Whilst the low level of inflation before the GFC suggests that the market rate was trending towards the natural rate of interest, the credit/asset boom seems to suggest that the market rate had been constantly below the natural rate. Alternatively, the PK economists argue that the concept of a natural rate of interest cannot offer either meaningful or consistent results under monetary analysis. The most influential tool is thus the policy rate, which is set exogenously by the Federal Reserve and influences the whole spectrum of interest rates in the market. This approach agrees, at least partially, with the position of Taylor (2018) , namely that the Fed should be held responsible for the GFC because it raised the policy rate too little, too late.

Following the review of the theoretical debate, the next chapter provides an empirical analysis of the GFC and comprehensively investigates all the logical links presented in this chapter.

3. The Global Financial Crisis - an empirical analysis

3.1. Introduction

Godley (1999) famously diagnosed — through empirical observation of sectoral financial balances[1] — that the growth trajectory of the US economy was unsustainable. In his analysis, Godley noted that the private sector expenditure to income ratio had been worsening since the end of 1991. In Fig. 3.1, the net lending positions of households and non-financial corporate (NFC) businesses were in constant decline during the 1990s, in contrast to previous decades. The positions of financial corporate (FC) and non-financial non-corporate businesses (NFNC) were roughly at zero per cent of US GDP. According to Godley and Wray (2000), private enterprises are profit-driven, and deficit positions never last long, because when firms experience a loss, they will engage in cost-cutting activities.

In contrast, the federal government tightened its fiscal position over an extended period of time. By the late 1990s, it had turned its position into a surplus, and the Congressional Budget Office (CBO) even projected that the position would last for the next 10 years. The external sector was also unlikely to improve, given the structural shifts in the global production chain that had taken place in the 1980s (see Section 2.3.1), and one-third of the world economy was still affected by the Asian financial crisis. An economic recession was inevitable if the private sector's deficit continued. Godley's prediction was confirmed by the bursting of the dot-com bubble in 2001.

[1] Godley's analysis is deeply rooted in national accounting. In this particular paper, his focus was on the net lending/borrowing positions (i.e., financial balances) of the three broad sectors of the US economy — the private, the public, and the external sector (2.5). He further developed this type of analysis into a full stock-flow consistent modelling framework in Godley and Lavoie (2007), which is explained in detail in the next chapter.

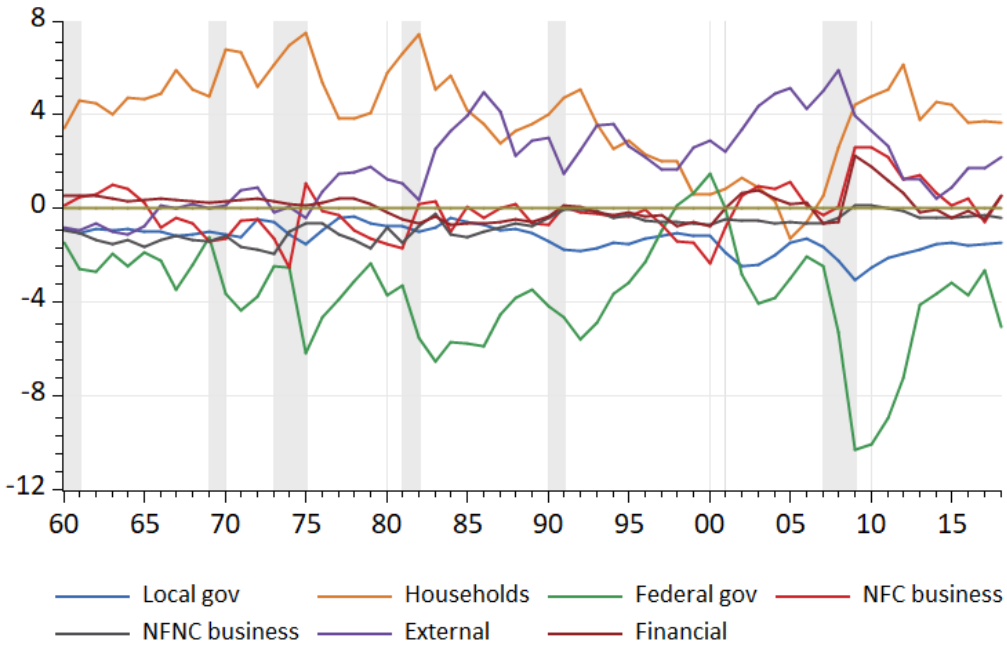
Using the same approach, Godley and Zezza (2006) also foresaw the 2007–09 financial crisis. The net lending/borrowing position of the private sector as a whole experienced a temporary bounce back after the dot-com bubble, and soon fell into a deficit position. This time it was households, not firms, that went into deficit. The ever-increasing ratio of private debt to disposable income after the 1980s would eventually slow down. A relatively small change in the debt stock to income ratio can have significant effects on the net lending (flow of debt) to income ratio. It can result in sustained recessions, because debt-financed consumption cannot sustain a negative household financial balance for long. Therefore, in the medium term, Godley and Zezza (2006) expected that there would be an improvement in the financial balances of both households and the external sector, due to the slowdown in domestic consumption. Moreover, the fiscal stance had to be biased towards much larger deficits so that recessionary pressures can be countered. This prediction later proved to be correct. Fig. 3.1 shows that the net lending positions of the households sector, the external sector, and the federal government were the dominating forces of the US sectoral balance dynamics prior to the crisis.

The sectoral financial balances are accounting identities, which cannot offer implications for causation. It is the interpretation of the causal factors behind the movement in financial balances that is essential in identifying the unsustainable growth path. Controlling for reverse causation requires more careful statistical inferences. Following the theoretical review of the global savings glut (GSG) hypothesis, the endogenous money (EM) hypothesis, and the global financing glut (GFG) hypothesis in the previous chapter, the purpose of this chapter is to examine the internal logic of each hypothesis using US data.

The logic chains of the three hypothesis are inter-related in nature, which is better presented in Fig. 3.2. The methodology section details the pros and cons of several empirical strategies. A single equation Error Correction Model (ECM) is selected after comparing the other primary econometric models in the time-series analysis. The rest of the sections investigate logic chains in Fig. 3.2.

The behaviour of households (as regards consumption) is critical to Godley's financial balances narrative in terms of understanding the financial crisis. Section 3.3 inquires into the determinants of US household consumption, which was responsible for falling private sector savings and the deterioration in the external balance. Three important channels that can affect household consumption are identified in

Figure 3.1.: The sectoral net lending/borrowing positions of the US economy, % of GDP, 1960-2018

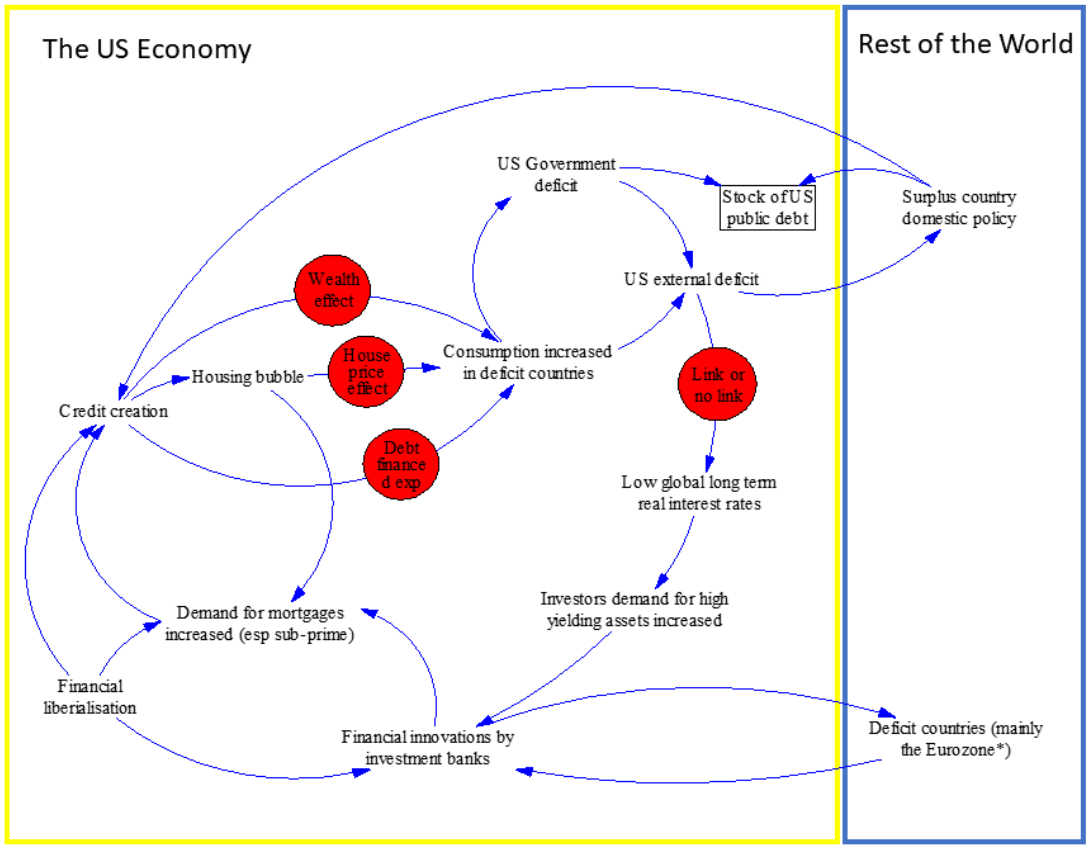


Source: National Income and Product Accounts, BEA, own calculation

this study. The first is the wealth effect, which is attributable to the specific impact of net financial wealth on household consumption. The second channel is the housing wealth effect. As the dominant component of households' non-financial assets, an increase in house prices enables households to access more lending secured against their properties. The third channel is debt-financed consumption, which captures both the effects of short-term credit and the possible linkage to mortgages.

Section 3.4 focuses on the determinants of the credit and housing boom, one must recognise the self-reinforcing cycle between the two. If credit issuance (mainly mortgages) exceeds the newly built properties and the supply of existing housing stock, it will inevitably exert upward pressure on housing prices. This, in turn, will increase demand for ever-larger mortgages. Fixed assets, such as housing and other property, can also be used as collateral for borrowing. Therefore, rising property prices enable property owners to take out larger and larger loans. As profits in the banking sector continue to grow, default risks also diminish, which encourages yet more lending (Ryan-Collins et al., 2017). To control the value effects, the number of mortgages

Figure 3.2.: Chains of logic reasoning for empirical analysis



Source: created by the author

(rather than their cumulative value) is used to conduct statistical inference. The volume effects can also be seen as a proxy for credit standards, which are mostly set by banks exogenously.

As regards the capital inflows into the US, two groups of countries stand out as the primary focus of the empirical investigation (see sec. 3.5): the current-account-surplus countries across the Pacific[2] and certain European countries, such as the UK and the Eurozone members across the Atlantic. Unlike the surplus countries in Asia, the UK's current account has been running a deficit for decades (since the mid-1980s), while the current account of the Eurozone was roughly balanced prior to the 2007–09 financial crisis. The current account balance only reveals net capital

[2]Although Germany is one of the world's major surplus countries, the pattern of German capital inflows into the US is more similar to other Euro Area economies than to Asian surplus countries. (See Fig. 3.11)

flows between two countries, which are responsible for the long-term changes in the net international investment position of an economy. Macroeconomic stability is at stake when an economy experiences a sudden stop in capital inflows. The capital inflows into the US from the Asian surplus countries mainly ended up in US Treasury securities and US government agency bonds, in accordance with the reserve management demands of those countries' officials. Investments in private-sector securities were limited. McCauley (2019) estimated the size of such inflows amounted to US$1.7 trillion. In contrast, the capital inflows from Europe, estimated at US$0.7 trillion, were essentially disguised as current account balance positions, since the gross capital inflows into the US were netted out by the large outflows to Europe from the US (Avdjiev et al., 2016). In fact, European commercial banks (which are not official institutions) were heavily engaged in the purchase of US corporate bonds[3] and equities.

Although the GSG hypothesis has theoretical flaws[4], we still need empirical evidence to challenge its external validity. Therefore, the investigation has focused on two central claims of the GSG hypothesis. The first concerns the direct effect of capital inflows from GSG countries on credit creation and the housing boom in the US. The second is the impact of the GSG on US long-term interest rates. The persistently low level of long-term interest rates was responsible for the increasing appetite amongst institutional investors in the US for high-yielding safe assets (Lysandrou and Shabani, 2018). If the massive purchase of Treasury securities by the surplus countries exerted downward pressure on long-term interest rates, then such capital inflows also contributed indirectly to the boom in asset-backed securities in the US private sector. This hypothesis mainly focuses on the demand side, whilst the EM hypothesis suggests that—given the presence of the shadow banking sector prior to the financial crisis—the regulatory framework cannot effectively limit the credit creation process (Lavoie, 2019). Therefore, it is the supply side, which significantly lowered credit standards (especially for mortgages), that should be regarded as the primary cause of the credit boom. By exploring the determinants of US long-term interest rates, the empirical analysis also contributes to the understanding of Greenspan's Conun-

[3]Bertaut et al. (2012) showed that, between the late 1990s and 2007, nearly half of the purchase of asset-backed securities was recorded under 'corporate bonds' in the Treasury's International Capital (TIC) database. These bonds were purchased by French or German banks, such as BNP Paribas and Deutsche Bank, through the international financial market. However, TIC data are only available at the country level, no bank level data are provided. See sec. 3.5.2 for a detailed description of capital flow data.

[4]See sec. 2.4 for a detailed explanation.

drum[5]. Similarly, keeping the credit/housing boom and long-term interest rates as the dependent variables, the GFG hypothesis requires further empirical evidence on the impact of capital inflows from European countries.

3.2. Methodology

Judging by the statistical relationships of interests and data format, the statistical estimations in this chapter mostly rely on time series analysis[6]. This section provides a brief account of the rationale behind our model selection. The properties of time series data, such as trend, seasonality, and stationarity, are essential in deciding which model to use in the analysis. The inappropriate specification will result in biased and misleading estimates. For instance, using a simple Ordinary Least Square (OLS) regression between two non-stationary time series can result in spurious correlations, that is, two or more totally unrelated variables may appear to show strong statistical relationships. This could be due to the presence of an omitted variable or the presence of common trends or merely a pure coincidence. Therefore, it is vital to observe the data before conducting any further statistical analysis.

In most of the time series analysis, the first step is to conduct unit root tests for all data series to identify their likelihoods of stationarity. A data series is said to be stationary ($I(0)$) when its probability distribution remains unchanged over time (Pesaran, 2015). If a data series follows a unit root process (i.e. non-stationary), then it cannot converge to a long-run value as its mean, variance, and co-variance are all changing over time. Considering a data generating process (DGP),

$$y_t = \mu + y_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim IID(0, \sigma^2) \tag{3.1}$$

where μ is a constant, also known as the drift parameter, y_{t-1} is the past value of the dependent variable y_t, and ε_t is a stationary error term with mean zero and

[5]See section 2.3.2 for more detail.

[6]As we only interested in examining the macroeconomic dynamics of the US economy, panel analysis is not discussed in this section.

constant variance σ^2. Given y_0 is the starting value of y_t, we get,

$$y_t = y_0 + \mu t + \varepsilon_0 + \cdots + \varepsilon_t \tag{3.2}$$

This DGP is also known as a random walk process. In this simple model, it is clear that the mean value, variance, and co-variance are all dependent on t. Therefore, without having a long-run relationship, it is entirely unpredictable.

Based on the unit root tests, we have three scenarios in the analysis: all variables of interests are either stationary or non-stationary, and both stationary and non-stationary time series co-exist in the data collection. In the first scenario, when all the variables are stationary, either OLS estimation if using a single equation or vector autoregressive (VAR) models if using a system of equations can produce unbiased estimation. If all the variables are non-stationary, then they are subject to cointegration tests. Only those that present cointegration relationships can lead to meaningful statistical inference. The existence of a cointegration relationship implies that there is a linear combination of two or more non-stationary variables, which is stationary. This concept was first proposed by Granger (1986) and further advanced by Engle and Granger (1987). More formally, assuming there are m $I(1)$[7] variables, which is given by (3.3),

$$y_{it} \sim I(1), \quad i = 1, 2, ..., m \tag{3.3}$$

Vector matrix[8] $\boldsymbol{y}_t = (y_{1t}, y_{2t,}..., y_{mt})'$ is cointegrated when there exists a parameter matrix $\boldsymbol{\beta}$ that can transform it into a $I(0)$ vector matrix (ξ_t),

$$\begin{array}{cccc} \boldsymbol{\beta}_t' & \boldsymbol{y}_t & = & \xi_t \quad \sim I(0) \\ (r \times m) & (m \times 1) & & (r \times 1) \end{array} \tag{3.4}$$

[7] I is the order of integration. $I(d)$ represents the successive number (d) of differences that are necessary to result a stationary time series. A variable (X_t) is integrated with an order d, can be represented by $(1-L)^d X_t$, where L is the lag operator. Therefore, $I(I)$ gives $(1-L)X_t = X_t - X_{t-1} = \triangle X_t$.

[8] The bold font indicates that the variable is under matrix form.

where the number of cointegration relationships, also known as the dimension of the co-integration space, r must be greater than one. These cointegration relationships represent long-run relationships (Pesaran, 2015).

The Johansen test is commonly used in identifying cointegration relationships, which was first proposed by Johansen (1988). Unlike the residual-based tests[9], which test the null hypothesis $r = 0$ against the alternative $r > 0$, the Johansen test focuses on the rank condition of the parameter matrix, which is applicable to identify more than one cointegration relationship. A generalised model with m variables is given by Shrestha and Bhatta (2018),

$$\underset{(m\times 1)}{\boldsymbol{x}_t} = \underset{(m\times m)}{A}\ \underset{(m\times 1)}{\boldsymbol{x}_{t-1}} + \underset{(m\times 1)}{\boldsymbol{\varepsilon}_t}, \quad t = 1, 2, ..., T \tag{3.5}$$

where A is a parameter matrix. Subtracting $\boldsymbol{x}_{t-1}$ on both sides, we get

$$\begin{aligned} \triangle \boldsymbol{x}_t &= (A - I)\boldsymbol{x}_{t-1} + \boldsymbol{\varepsilon}_t \\ &= \Pi \boldsymbol{x}_{t-1} + \boldsymbol{\varepsilon}_t \end{aligned} \tag{3.6}$$

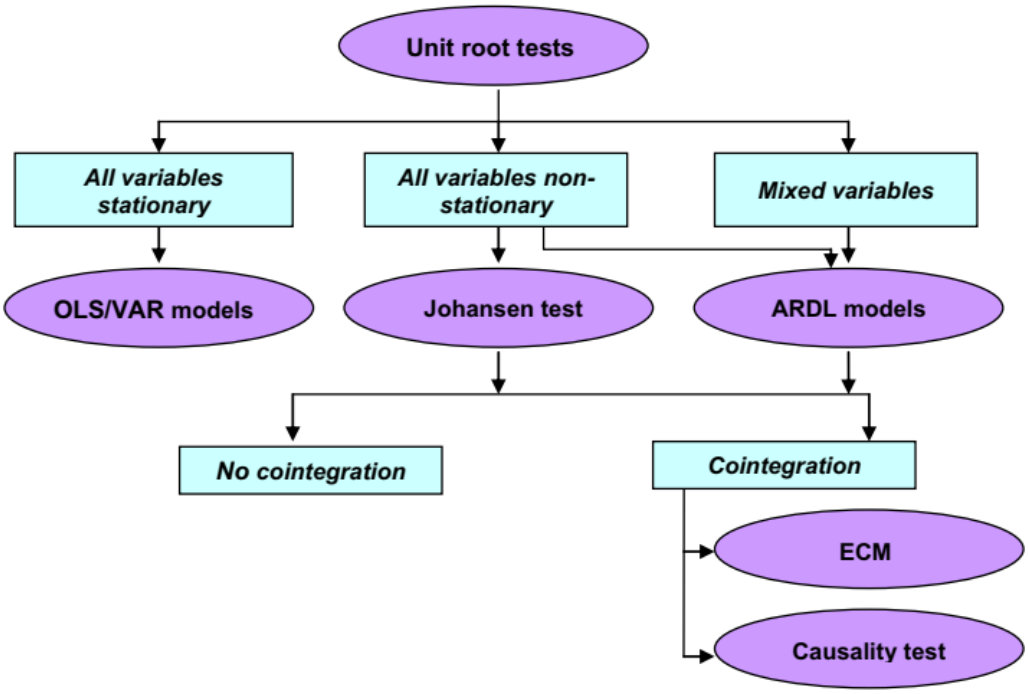
the null hypothesis is the rank of Π, r, is less than full rank m and against the alternative $Rank(\Pi) = r + 1,\ \ r = 0, 1, ..., m - 1$, if the test uses the maximum eigenvalue approach or $Rank(\Pi) = m$, if it follows the trace approach. Both tests rely on the log-likelihood ratio statistics[10]. The DGP has a unit root when $Rank(\Pi) = 0$. The number of cointegration relationships is then the highest non-rejected value of r. When there is a full rank condition ($Rank(\Pi) = m$), then all variables are stationary ($I(0)$), both OLS and VAR models in levels are appropriate.

Traditional cointegration methods, such as the Johansen test and residual-based tests, require all the variables are of the same order of integration, usually $I(1)$. When there is a mixed order of integration, that is, some series are $I(0)$ while others are $I(1)$, then it fails the preconditions of cointegration and has a risk of

[9]These tests, proposed by Engle and Granger (1987), requires two steps. The first step is to estimate the parameter using standard OLS regression and obtain the estimated residual from the equation. Then, in the second step, a unit root test is conducted to confirm the stationarity of the estimated residual. If it is stationary, then there is a cointegration relationship between the dependent and the independent variables.

[10]For technical details, please see Johansen (1991).

Figure 3.3.: Method selection for time series data



Source: Shrestha and Bhatta (2018)

misspecification. Another shortcoming of the Johansen test is that it is subject to asymptotic properties. Therefore, when the sample size is not sufficient, it will generate unreliable results. An AutoRegressive Distributive Lag (ARDL) model[11] has proven to be advantageous under both situations (Pesaran et al., 2001; Pesaran and Shin, 1998). A standard ARDL model is an OLS based time series regression model. Equation (3.7) provides a general form of ARDL model,

$$y_t = \lambda_0 + \lambda_1 t + \sum_{i=1}^{p} \psi_i y_{t-i} + \sum_{j=1}^{k} \sum_{l_j=0}^{q_j} \beta_{j,l_j} x_{j,t-l_j} + \varepsilon_t \tag{3.7}$$

where ψ_i and $\beta_{j,l_j}$are the parameters assigned for lagged dependent variable y_t and the k independent variables as well as their lagged variables respectively. ε_t assumes to be an independent and identically distributed (IID) random variable. The term AutoRegressive highlights another key feature of time series data, that is, the current

[11]Notice that there should not have any data series with an order of integration above one, which will invalidate the methodology (Pesaran, 2015).

value of dependent variable is determined by its own lagged values[12]. Therefore, given the number of lags for both the dependent variable (p) and the regressors (q), Equation (3.7) is known as the $ARDL(p, q)$ model.

An Error Correction Model (ECM) is a general transformation of the ARDL model. When all variables of interest are of the same order of integration (often $I(1)$) and co-integrated[13], ECM and ARDL model are technically the same. Engle and Granger (1987) demonstrated that cointegrated time series are well represented by an ECM. The logic of the cointegration relationship between two or more variables implies that there is an equilibrium relationship connecting them. The residual estimated by the OLS regression measures the level of deviations that these variables are away from the equilibrium. In a dynamic model, the change in the current value of the dependent variable is not only determined by the changes in the current value of regressors, but also by the level of disequilibrium effect of the previous period, which is a typical ECM setup.

While the AutoRegressive Integrated Moving Average (ARIMA) and VAR models are often accused of having little support from economic theories, the ECM offers a way to combine the long-term co-integration relationship based on established theories and the flexibility to specify the lagged structure that best fits the data. Economic theories have two critical functions in the use of ECM. The first is to help select explanatory variables and the second is to identify cointegration relationships (Kennedy, 2003). Therefore, the ECM is used to model equilibrium relationships involving stationary time series as well as cointegrated time series. Like ARDL models, ECM contains both short-term (changes) and long-term (levels) equilibrium relationships and provides stability to the system (Bryman et al., 2004).

A simplified two-variable ECM example is given by (3.8),

$$\triangle y_t = \lambda_0 + \lambda_1 \triangle x_t + \gamma_1 y_{t-1} + \gamma_2 x_{t-1} + \varepsilon_t \tag{3.8}$$

where γ_1 is the error correction rate. It is the rate at which disequilibrium between y_{t-1} and βx_{t-1} ($\beta = \gamma_2/\gamma_1$) is corrected. It is essential for the absolute value of γ_1

[12] An $AR(p)$ process is given by $y_t = \lambda_0 + \lambda_1 y_{t-1} + \cdots + \lambda_p y_{t-p} + \epsilon_t$.

[13] Considering a case of two variables. If one of the data series is $I(0)$, which means it's roughly constant over time, while the $I(1)$ variable is increasing over time, then it seems impossible to have co-integration relationship.

to stay within the range of $[-1, 0)$ to ensure convergence. λ_1 is the coefficient for short-term effects. Under the first difference, both Δy_t and Δx_t become $I(0)$.

To ensure an unbiased estimation of λ_1, the contemporaneous element (x_t) within regressor variable, Δx_t, should also be exogenous to the contemporaneous disturbance term ε_t. This is known as the weak exogeneity assumption[14]. The assumption can be tested using the instrumental variable approach with lagged variable Δx_{t-1} as the instrumental variable (IV) for Δx_t. If the two-stage least squared (2SLS) estimator ($\hat{\lambda}_{2SLS}$) is not statistically significantly different from the OLS estimator ($\hat{\lambda}_{OLS}$), then the weak exogeneity assumption holds true. If the assumption is violated, that is when the two estimators are statistically different, then $\hat{\lambda}_{2SLS}$ should be the preferred estimator. The endogeneity test[15] results are given in Appendix-A.

In addition, if the theory successfully specifies the long-term relationship, then the error term $\varepsilon_{t-1} = y_{t-1} - \beta x_{t-1}$ should be stationary. Therefore, (3.8) can be estimated using simple OLS regression[16].

For example, assuming that households consumption is positively associated with the level of credit access, that is, easy access to credits is associated with higher levels of households consumption. It is a long-run equilibrium relationship between the two variables. If the financial sector decides to tighten the supply of credits, due to a temporary financial retrenchment, the aggregate consumption is likely to fall in the short run. In this case, the two series deviate away from their long-run equilibrium, and we would expect the supply of credits to return to the pre-crisis level. ARDL or ECM models are suitable to capture such relationships. However, the correction rate γ can only be estimated under the ECM set-up as shown in the equation above.

In addition to the simple OLS estimation, the Engle-Granger two-step method is often used under cointegration. Before the first step estimation, it is important to identify the order of integration for both variables. If they are of the same integration order (usually $I(1)$), then we can proceed to the first-step regression that estimates the long-run relationship only. The estimated residual is subject to unit root tests to confirm whether it is indeed stationary, given the assumption that

[14]The strict exogeneity condition requires the disturbance term to be independent from all the dependent variables at all periods, $E(u_t|\boldsymbol{X}) = 0, \quad t = 1, ..., T$.

[15]Under the null hypothesis, the short-term change variables that contain the contemporaneous elements are exogenous.

[16]The specification does not identify the parameter β, unless the lagged y and x are separately estimated. The estimated parameter for x_{t-1} is $\gamma\beta$.

the two variable are cointegrated. If the disequilibrium residual term is $I(0)$, then it enters the second-stage error correction equation in (3.8) by replacing $y_{t-1} - \beta x_{t-1}$. According to Kennedy (2003), the two-step estimation is subject to bias when the sample size is small. Joint estimation of both long-run relationship and short-run dynamics (e.g. Equation (3.8)) performs better than the Engle-Granger two-step method under Monte Carlo studies.

One limitation of using a single-equation ECM is that the independent variables are implicitly assumed to be exogenous. As Sims (1980) pointed out, in macroeconomics, the dependent variables and independent variables are endogenous to each other, which led to the development and popularity of VAR analysis to solve this simultaneity problem. Another limitation is that when the estimation has more than two variables, then there is a possibility that more than one cointegrating relationship exists. Then specifying the equations in simultaneous systems such as VAR[17] and Vector Error Correction Model (VECM)[18] could be advantageous. The number of cointegration relationships can be identified using the Johansen test.

However, the VAR models are also not free from criticism. According to Asteriou and Hall (2007), the VAR models are typically atheoretical. There are no restrictions on estimated parameters as all variables are mostly endogenous to each other. Therefore, interpreting the coefficients can be difficult. Granger causality tests are often conducted to make statistical inference on the coefficients. After dropping out the coefficients that are not statistically significant, it may result in a VAR model that is consistent with economic theories.

Moreover, having a large number of lags and variables suggested by different theories in a model is extremely data consuming and massively reduces the degrees of freedom. When the sample size is not large enough, the estimation can even be misleading

Based on the pros and cons of each estimation strategy stated above and the data availability, this chapter chooses single-equation ECM as the preferred estimation strategy. Firstly, the study aims to examine established hypotheses. With single-equation setup, it is able include numerous explanatory variables based on different claims made by each theory. Secondly, some explanatory variables of interest (e.g. the number of mortgages issued in the US before financial crisis) are subject to

[17]VAR is essentially a system of ARDL equations

[18]VECM is a generalisation of VAR. Adding multiple long-run relationships (error correction terms) to the short-term dynamics in the system.

availability issue, which could lead to biased results when using VAR or VECM. The choice of lag structure is also relatively flexible under single-equation ECM.

Another limitation of the single-equation ECM is that the specification may not capture all the other possible co-integration relationships, especially when it involves more than two variables[19]. Pesaran and Pesaran (2009) demonstrated how a bounds test can be used to examine the number of long-run cointegration relationships and direction of causality for a single-equation ECM under such situations. For illustrative purpose, we introduce a third long-run variable z_{t-1} into (3.8),

$$\triangle y_t = \lambda_0 + \lambda_1 \triangle x_t + \lambda_2 \triangle z_t + \gamma_1 y_{t-1} + \gamma_2 x_{t-1} + \gamma_3 z_{t-1} + \varepsilon_t \tag{3.9}$$

The null hypothesis of the bounds test assumes $\gamma_1 = \gamma_2 = \gamma_3 = 0$, that is, there are no long-run relationships between y, x and z. If the F-statistic ($F(y|x,z)$) exceeds the upper bound of the critical value band at 95 per cent level[20], we can reject the null hypothesis. On the other hand, if the F-statistic falls below the lower bound of the critical value band, we cannot conclude that there is long-run relationship among the three variables. The same diagnostic procedure can be applied when more variables are introduced to the ECM model.

To test whether x and z are the long-run forcing variables for the explanation of y or not, we need to rearrange (3.9) into the following forms and conduct two more F-tests:

$$\triangle x_t = \lambda_0 + \lambda_1 \triangle y_t + \lambda_2 \triangle z_t + \gamma_1 y_{t-1} + \gamma_2 x_{t-1} + \gamma_3 z_{t-1} + \varepsilon_t \tag{3.10}$$

$$\triangle z_t = \lambda_0 + \lambda_1 \triangle x_t + \lambda_2 \triangle y_t + \gamma_1 y_{t-1} + \gamma_2 x_{t-1} + \gamma_3 z_{t-1} + \varepsilon_t \tag{3.11}$$

where Δx_t is the dependent variable and γ_2 is the error correction rate in (3.10) and Δz_t is the dependent variable and γ_3 is the error correction rate in (3.11). If $F(x|y,z)$

[19]When we have only two variables, the Granger test can be used to examine pairwise causality.
[20]For technical details and computed critical value bounds, please refer to Pesaran et al. (2001).

and $F(z|y,x)$ both fail to reject the null hypothesis, we can now conclude that x and z have a direct impact on y and the co-integration relationship is unique. However, if one of the F-statistic or even both F-statistics exceed the upper bound of the critical value band at 95 per cent level, then there are more than one co-integration relationships among the three variables and the direction of causality is not certain. Appendix-A presents the results of bounds test for a selection of equations from each ECM model for demonstrative purpose. Given the complexity of the macroeconomy, a unique co-integration relationship and one-way causation are rarely the case when there are more than three macroeconomic variables involved. Ultimately, the ECM model specifications and lag structures are selected based on economic theories and variables of research interest.

3.3. Understanding US household consumption

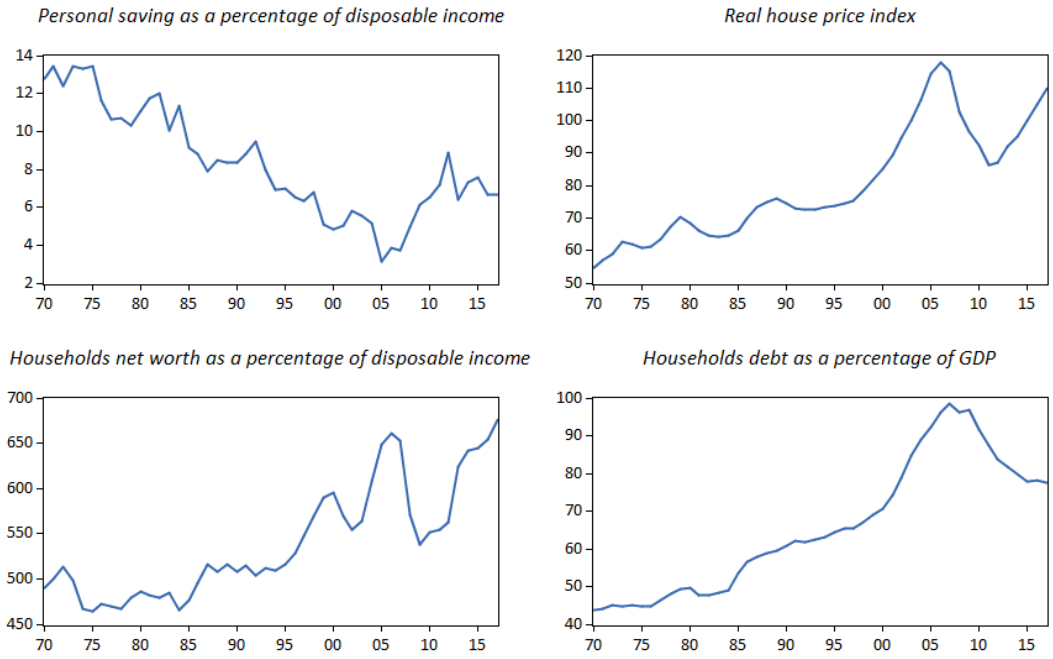
Household consumption[21] is the most significant component of US GDP. Personal consumption expenditure as a percentage of US GDP increased steadily from 61 per cent in 1980 to 68 per cent just before the onset of the financial crisis. This share remains high even today. As Fig. 3.4 shows, the US personal saving (i.e. the households income left unconsumed) as a percentage of disposable income has been in decline for more than three decades since the breakdown of Bretton Woods system in 1971. During the same period, the US house price together with households net worth and debt has increased significantly. The 2007-09 financial crisis ended this trend with a structural break. Given its importance, the empirical literature that examines the determinants of households consumption is vast. The literature review of this section only focuses on the three likely channels that may have significantly contributed to the US households consumption boom prior to the financial crisis: the financial wealth effect, the housing wealth effect, and debt-financing effect.

3.3.1. Literature review

Ando and Modigliani (1963) were amongst the very first to quantify wealth effects on household consumption. However, their consumption equation was based on the

[21]Empirical data also includes nonprofit institutions serving households (NPISH).

Figure 3.4.: Stylised facts, US households sector, 1970-2017



Source: BEA, IMF, and OECD. Created by the author

life-cycle hypothesis[22] which is closely related to the permanent income hypothesis at a micro-level. The hypothesis is consistent with the theoretical foundations of the Euler equation (see Hall (1978)) and the rational expectations hypothesis, which was widely applied in mainstream Dynamic Stochastic General Equilibrium (DSGE) models before the crisis. It assumes that individual agents maximise their utilities resulting in consumption smoothing behaviour and by having rational expectations regarding their life-time earnings. Therefore, their current level of consumption (c) should be proportional to their total wealth[23] (w), which is given by $c = mpc^w w$. mpc^w is the individual agent's marginal propensity to consume (MPC). Assuming that this individual agent is representative of the entire economy, the aggregate consumption function follows the exact form of his/her consumption function[24]:

[22] In the life-cycle hypothesis, the propensity to consume of the agent changes with the his/her age. Aggregation across the age structure of the population of households gives the aggregate consumption. Households only borrow or save passively to achieve the optimum degree of smoothing of expected future labour income, i.e. non-property income.

[23] Some papers, such as Davis et al. (2001), include the human wealth, tangible assets, and financial assets. Human wealth measures the present value of life-time earnings. The tangible assets and financial assets often refer to the net worth.

[24] See Altissimo et al. (2005) for a detailed discussion on micro theories.

$C = mpc^w W$. Poterba (2000) estimated mpc^w for US households to be between 2.7 and 10.3 cents; that is, for every dollar increase in the wealth of a household, its consumption will increase by 2.7 to 10.3 cents.

Altissimo et al. (2005) along with many others, showed that the marginal propensity (mpc^{w_i}) to consume out of wealth can differ significantly across different assets. Non-equity financial wealth appears to have the highest MPC. There is no clear indication as to the MPC that is generated by equity financial wealth or housing wealth. According to the life-cycle and permanent income hypotheses, like with other assets, a negative shock to the value of housing lowers the permanent income of households, which affects their consumption/saving decisions over the life-cycle. However, there is still no consensus regarding housing wealth effects in the empirical literature. Sousa (2009) found that households responded more to positive changes in currency and deposits (between 3.7 cents and 5.8 cents[25]) than in share values (between 0.73 cents and 1.2 cents). In addition, although mortgage loans are financial liabilities for households, the estimated MPC is both positive (between 3.4 cent and 7.3 cents) and statistically significant. Overall, the net housing wealth effect is close to zero. Barrell et al. (2015) confirmed the significance of financial wealth effects in Italy and the UK.

Interestingly, even though the authors found no housing effects in Italy, they found that UK household consumption appeared to respond to housing wealth even more than financial wealth. Their results are consistent with Carroll et al. (2011). Girouard (2010) showed that, within the OECD countries, the different results as regards housing effects could be due to country-specific features in mortgage markets. Countries with higher mortgage-to-GDP ratios or higher housing equity withdrawal (HEW)[26] over disposable income[27] are also associated with higher MPC generated by housing wealth. Therefore, it is sensible to have housing wealth included in our model.

According to Muellbauer (2016) and Deaton (1992), both representative agents and rational expectations are highly unrealistic at the micro-level, and the Euler equation fails to find support from aggregate consumption data. For example, the life-cycle

[25]The different results were due to the use of different econometric technique. The IV/GMM estimates were consistently lower than the Dynamic OLS estimates.

[26]HEW refers to the change in housing equity stock, which is the net value between the stock of housing wealth and stock of lending secured on housing. A positive value of HEW implies a decline of the stock of housing equity. A negative value is a housing equity injection, which adds onto the stock of housing equity. (Reinold, 2011)

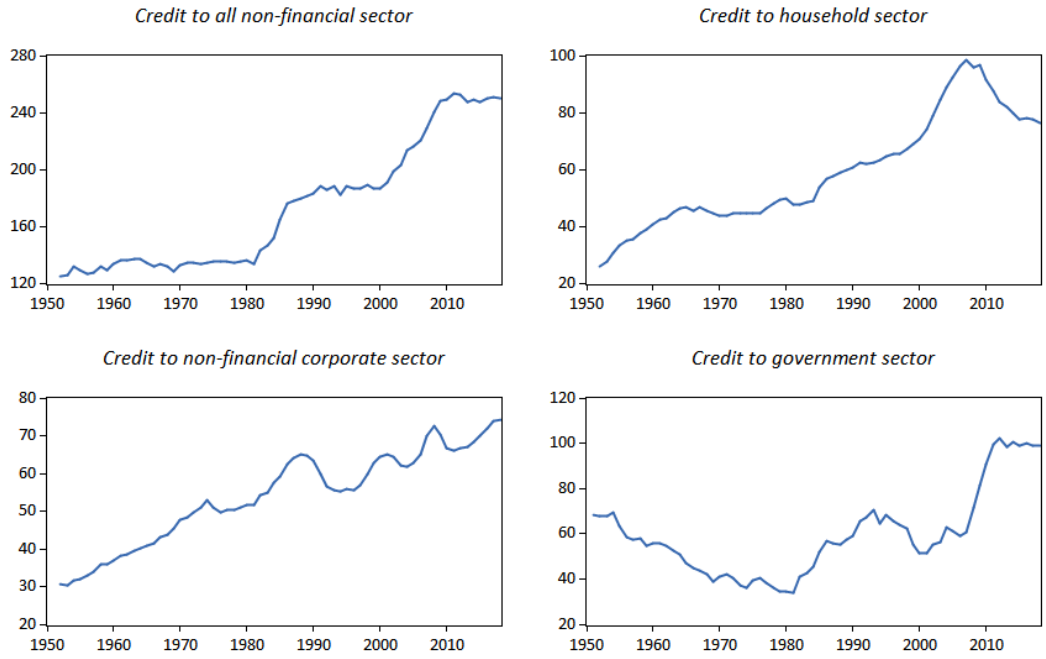
[27]These countries are Australia, Canada, the Netherlands, the UK, and the US

hypothesis suggests a strong positive correlation between housing prices and household savings, which is clearly inconsistent with the data in Fig. 3.4. Such a view fails to reflect the endogenous money-creation process in the modern banking sector and does not recognise the essential role played by housing and mortgages in influencing macroeconomic dynamics in the long-run (Ryan-Collins et al., 2017). Housing is different from other non-financial assets in that it is deeply entangled with the credit markets in a modern economy such as the US'. Aron et al. (2012) argued that the housing–credit interaction process can impact on household consumption in two ways - the down payment effect and the collateral effect, which may account for the higher housing wealth effects observed in the US.

The down payment effect is closely related to the structural shifts that have taken place in the domestic credit market in the US. As one of the indicators of financial liberalisation, a relaxation of the down payment requirement has enabled households to acquire a mortgage of the same size with fewer deposit savings. It has thus increased households' consumption-to-income ratio (Muellbauer and Williams, 2011). The consumption-to-income ratio can also decrease (or increase by less) if the house price-to-income ratio grows too fast (Muellbauer, 2016). In fact, the US economy has experienced two major structural shifts in its credit markets (see Fig. 3.5): the total credit-to-GDP ratio rose significantly in the early 1980s and again in the early 2000s. In the 1980s, this was mainly due to credit expansion towards the government sector. In the early 2000s, however, it was household credit, which exploded from 70 per cent of GDP in 2000 to 96.6 per cent in 2009. According to Mian (2019), this trend was not unique to the US; in fact, the global credit-to-GDP ratio increased from 150 per cent of global GDP in 1980 to over 250 per cent in 2016. A large share of the increase was due to the expansion of private bank credit in advanced countries. Jordà et al. (2016) showed that, after the Second World War (WWII), real estate lending as a share of total bank lending in advanced economies doubled from 30 per cent in the 1950s to nearly 60 per cent in 2013.

The collateral effect of housing, meanwhile, has also been amplified since the 1980s, not only through rising house prices but also because of the significantly wider access to credit by households in the US. According to Jordà et al. (2016), the loan-to-value (LTV) ratio surged from 28 per cent in 1980 to 50 per cent in 2013. Klyuev and Mills (2007) argued that HEW improved the liquidity of housing assets and provided a critical link between the amplified collateral effect and household con-

Figure 3.5.: Credit to non-financial sector as a percentage of GDP, US, 1952-2018



Source: BIS, created by the author

sumption. Belsky (2004) constructed a simple HEW proxy for the US[28], calculated using the difference between the net change in households' mortgage liabilities and their expenditure on new residential houses. This proxy thus reflects the amount of lending that is secured on housing properties which does not add to the stock of housing wealth. This amount can be used to finance household spending and investment. They noticed that cash-out mortgage refinancing surged in the early 2000s. Reinold (2011) demonstrated various ways in which households can draw on housing equity. For example, if a multiple-property owner sells an existing house to a first-time mortgage taker without buying a new one, then part of the proceeds released from the housing market can end up in household consumption. Ryan-Collins et al. (2017) argued that HEW is an essential driver of consumer demand, and that it supported the fast economic growth in the UK before the financial crisis.

[28]For a more sophisticated version, see Greenspan and Kennedy (2008).

3.3.2. Model and data

Based on the literature review, the ECM equation for US household consumption (c^h) is given by (3.12).

$$\begin{aligned}\Delta c_t^h = \beta_0 + \beta_1 c_{t-1}^h + \beta_2 nw_{t-2}^{fin} + \beta_3 w_{t-2}^h + \beta_5 cs_{t-1} \\ + \beta_6 yd_{t-1} + \boldsymbol{\beta_i'control_{it-1}} + \boldsymbol{\alpha_i'}\Delta \boldsymbol{sr_{it}^c} + \varepsilon_t^c\end{aligned} \tag{3.12}$$

where nw^{fin} is the net financial wealth of US households, w^h is the housing wealth, cs is the real value of consumer credit liability and yd stands for household disposable income. $\boldsymbol{\Delta sr^c}$ is a vector (in bold) that contains the first difference of all the long-run variables of interest and other variables such as the the net increase in households' mortgage liability, $\triangle mortl$, which may have short-run effects. All the variables are deflated using the consumption deflator, and hence represent real values (in lower cases). Having only one lag for the short-term variables in the model is a choice based on the rule of thumb. Although econometric software such as Eviews can select the optimal number of lags in the model[29] based on various information criteria (e.g., Akaike Information Criteria), there is generally less economic meaning in the coefficients of the second lag and beyond. The net financial wealth and housing wealth are in second lags because they are the opening balance value for period $t-1$.

Real household consumption is the real personal consumption expenditure series in the National Income and Product Account (NIPA), which measures consumer expenditure on goods and services. Household disposable income is also from the NIPA, and is after-tax real personal income. US household assets are divided into two broad categories — financial and non-financial assets. Both the total financial assets and the net financial assets[30] of households are tested in the model (see Tab. 3.1). This data can be found in the US Financial Account (Z.1), which provides detailed flows of funds as well as sectoral balance sheet data. As the financial liabilities of the households sector, both consumer credit and mortgages are also included in the Financial Account. Non-financial assets, such as housing wealth

[29]The model that offers the best goodness of fits in statistical sense.
[30]Net financial assets = total financial assets - total financial liabilities

data[31], are from the balance sheet under non-financial assets in the BEA's national accounts. All the variables are annual data and are measured in millions of US dollars.

3.3.3. Results

Table 3.1.: Estimated results from the US households consumption equation

	(1_1)	(1_2)	(2_1)	(2_2)
	1970-2007	**1970-2017**	**1970-2007**	**1970-2017**
Long-run (beta) relationships				
Constant	-367584.6***	-16257.00	-167798.4***	-97731.28*
	(0.0043)	(0.7873)	(0.0027)	(0.0906)
Housholds consumption (-1)	-0.955000***	-0.334158***	-0.569050***	-0.283370***
	(0.0003)	(0.0015)	(0.0003)	(0.0056)
Net financial wealth (-2)	0.000925	0.005107		
	(0.8698)	(0.1459)		
Total financial assets (-2)			0.007092*	0.000455
			(0.063)	(0.8958)
Housing wealth (-2)	0.003360	-0.009015		
	(0.8307)	(0.4254)		
Mortgage liability (-1)				
Estimated HEW (-1)			0.158394**	0.166724***
			(0.0257)	(0.0001)
Consumer credit (-1)	-0.009256	-0.088438	-0.064055	-0.074018
	(0.9435)	(0.2966)	(0.5017)	(0.4411)
Disposable income (-1)	0.883283***	0.306632***	0.517161***	0.284933***
	(0.0001)	(0.0011)	(0.0001)	(0.0030)
Short-run (alpha) relationships				
Δ Net financial wealth (-1)	0.004014	0.021523***		
	(0.5242)	(0.0001)		
Δ Total financial assets (-1)			0.027655***	0.014256***
			(0.0000)	(0.0008)
Δ Housing wealth (-1)	0.135577**	-0.043517		
	(0.0126)	(0.1993)		
Δ Mortgage liability	0.003297	0.216222***		
	(0.9662)	(0.0000)		
Δ Estimated HEW			0.306782***	0.199145***
			(0.0032)	(0.0021)
Δ Consumer credit	0.437890**	0.435512***	0.496774***	0.467804***
	(0.0108)	(0.0009)	(0.0003)	(0.0009)
Δ Disposable income	0.665262***	0.306632***	0.419448***	0.390990***
	(0.0000)	(0.0011)	(0.0000)	(0.0000)
Adjusted R-squared	0.877954	0.912358	0.921595	0.881239
Durbin-Watson statistics	1.850924	1.793249	2.052539	1.633445

P-values are in parenthesis
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively

[31]To be more specific, it is the dwellings of the households' tangible fixed assets. Non-residential buildings and machinery are not included.

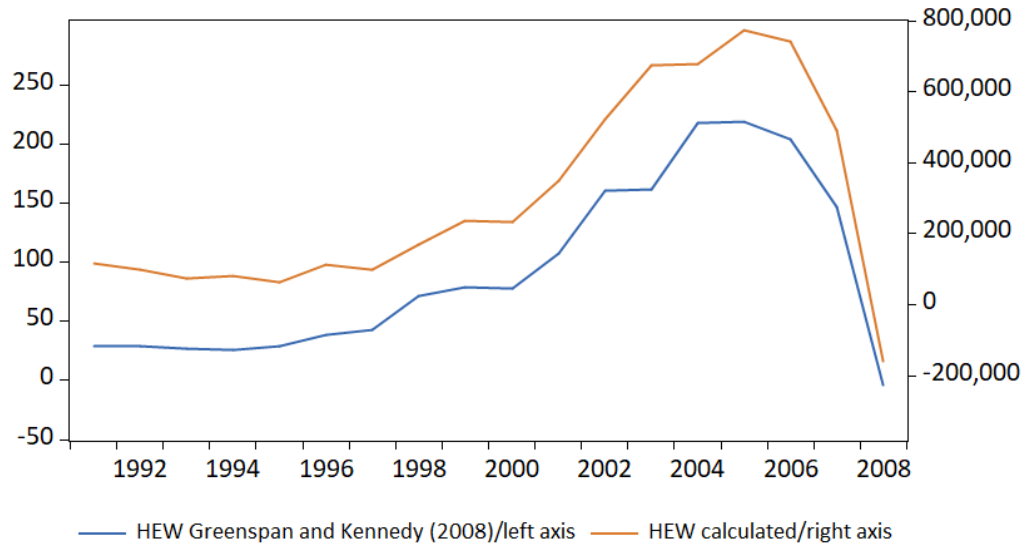
The empirical findings are broadly in line with the literature and fit the data quite well. Regressions (1_1) and (1_2) estimate the same equation but in two different periods. Notice that the error correction rate is given by the coefficient of the first-lag of household consumption. The coefficients of the long-run co-integration relationship have to be derived by dividing the coefficient error correction rate. For example, the long-run MPC for households disposable income is 92.5 cents in regression (1_1) using data between 1971 and 2007. It is the quotient between the coefficient of disposable income (0.883) and the absolute value of the error correction coefficient (0.955).

In regressions (1_1) and (1_2), no long-run effect is identified for net financial wealth. The long-run effect of housing wealth also appears to be statistically insignificant. However, housing wealth and net financial wealth seem to contribute to the households' consumption in the short-run, as the coefficients for changes appear to be positive and statistically significant in regression (1_1) and (1_2) respectively. Considering the housing price and mortgage lending have reinforcing impacts on each other, there might be some interaction effects with mortgages. The inclusion of the changes in mortgage liabilities indeed diminishes the housing wealth effects and the statistical significance in the short run in both regressions. The short-term effect of mortgage liabilities becomes highly significant when the post-crisis period is included.

Consumer credit is the largest component (more than 80 per cent) of households' short-term liabilities. However, its contribution to household consumption does not show any statistical significance in both periods in the long-run. Counter-intuitively, the coefficients suggest that there is a negative relationship between total consumer credit liabilities and household consumption, but the same result was found for the UK by Gudgin et al. (2015), where the negative relationship may have captured the crowding-out effects of repayments. Consumer credits appear to be positively correlated with households consumption in the short-run dynamics.

Regressions (2_1) and (2_2) estimate an alternative model to test the robustness of our results. The same two periods are used in the model for comparison. The equation replaces households' net financial assets with total financial assets, and uses a simple HEW proxy, derived using the method proposed by Belsky (2004), to capture the interaction effect between the housing wealth and credit issuance. Both are highly significant in the short-run dynamics. The calculated HEW index is gen-

Figure 3.6.: Housing Equity Withdrawal indexes compared, US, 1991-2008



Source: Greenspan and Kennedy (2008) and own calculation

erally in line with the HEW data estimated by Greenspan and Kennedy (2008) (see Fig. 3.6), which offers quality assurance for the estimation method. In addition, our HEW index can easily be extended to cover the entire estimation period (1970–2017) using publicly available data, while the Greenspan and Kennedy (2008) method requires data at a more granular level. The MPCs for the HEW index are as high as 27.83 cents and 58.83 cents in regressions (2_1) and (2_2) respectively. The change in the structure of the estimation equation did not alter or undermine the main results identified by regressions (1_1) and (1_2), but they are outperformed by regressions (2_1) and (2_2) in terms of both statistical significance for estimated coefficients and explanatory power.

The high HEW effect suggests that the interaction between the US credit and housing markets indeed requires further investigation. The next section intends to test the EM hypothesis, and provides a detailed review of the domestic factors for each market.

3.4. The domestic determinants of the US credit and housing boom

The credit market and the housing market together played a critical role in bringing about the US 2007–09 financial crisis (see sec. 2.2.3). The two markets reinforced each other and created a feedback loop that led to a joint boom–bust cycle, which also resulted in significant cycles for other macroeconomic variables (see sec. 3.3 for a detailed discussion on the impact on household consumption). A relaxation in lending standards enabled previously financially-constrained borrowers to access credit, such as a mortgage, which increased the demand for housing and fuelled the housing boom. An asset price boom can itself lead to more demand for such assets and consequently, more credit disbursements. If the expected future growth in house prices continues to exceed income growth, then the demand for housing and credit will end up in an upward spiral.

The EM hypothesis argues that when a mortgage is issued, an equal amount of bank deposits will be credited to the home buyer's bank account and end up in the home seller's account. Money is thus created through lending, which does not necessarily reduce the volume of money in circulation or economic activity somewhere else. Money destruction works in a reverse process. When a loan is repaid by the borrower, the balance sheet of the bank will shrink as money supply contracts. According to McLeay et al. (2014), the majority of the money supply in a modern economy is created by the banking system via lending, with the remaining coming from the central bank[32].

The empirical literature on the determinants of the housing market is vast. The literature review in this section only focuses on the empirical evidence regarding the domestic factors that may have caused the boom in the US credit and housing markets in the run-up to the financial crisis. The effects of international capital flows will be discussed in the next section.

3.4.1. Literature review

House price

[32]Ryan-Collins et al. (2017) argued that 97 per cent of the money supply in the UK is created by bank lending.

Muellbauer (2012) claimed that there are two widely used house price models that can serve as the basis for empirical estimation: the inverted demand curve approach, and the rent arbitrage approach. Both models are derived from economic theory, and all the variables are in log-linearised form. The inverted demand curve model (3.13) is derived from the partial equilibrium analysis of the housing market. The price of housing is the result of the interplay between the housing supply curve and the demand curve. A downward-sloping demand curve implies that the price of housing (hp) is negatively correlated with housing demand (h^d). Other demand curve shifters, such as real household income (y), can also be included in the model. The coefficient α is the elasticity of house price to income.

$$ln(hp_t) = \alpha ln(y_t) - \beta ln(h_t^d) \tag{3.13}$$

In the long run, the price of housing brings supply and demand into equilibrium. Short-term price fluctuations occur mainly due to changes in the demand side. For example, Guerrieri and Uhlig (2016) described how a bubble mentality and irrational beliefs can cause housing demand to deviate from the economic fundamentals. The responsiveness of house prices to demand is also subject to the price elasticity of supply. According to Caldera and Johansson (2013), housing stock cannot respond to demand swiftly, because there are a time lag and physical constraints to building new houses, and also depreciation happens slowly. The elasticity of supply in the US is the highest amongst OECD countries, estimated to be at around 2, which is four times higher than in countries such as France or Germany. Therefore, compared with other countries, the same demand shock will result in a smaller price increase in the US.

Institutional factors can also help explain heterogeneity in housing supply across countries. For example, urban planning and land policies, such as the greenbelt policy in the UK and Hong Kong, can limit land supply for housing development. (Ryan-Collins et al., 2017). In contrast, German local authorities have much greater regional autonomy over planning. Therefore, other things being equal, UK house prices can be expected to grow faster than in Germany in the face of the same demand shock (Muellbauer, 2018).

Geng (2018) pointed out that if the price of housing deviates too much from the economic fundamentals for an extended period of time, then the inevitable price correction (in the long run) can pose a severe threat to macroeconomic stability.

A debt-financed boom in housing demand can be particularly harmful, which was indeed the case with the housing boom in early 2000. In Fig. 3.7, the cyclical patterns for the real price of housing and the household debt proxies are highly correlated.

Figure 3.7.: HP filtered real house price, number of mortgages, and household debt to GDP ratio in the US, 1970-2018

Source: BIS, OECD, and own calculation

The rent-arbitrage model (3.14) suggests that the house prices to rent (HTR) ratio should, in the long run, be equal to the real user cost of housing [33] (uc^h) in a frictionless housing market due to arbitrage behaviour between owning and renting a property. Given that in the US housing rents are highly market-driven, the model seems appropriate for modelling US house prices. For countries that have more policy interventions[34], the model is thus less useful.

$$ln(hp_t) = ln(rent_t) - ln(uc_t^h) \tag{3.14}$$

Muellbauer and Williams (2011) controlled for a wide range of other variables to test the validity of the theory. In their model for Australia, the credit condition index captures the structural shifts in the economy due to financial liberalisation and explains a significant part of the increase in house prices over the long-run.

The model developed by Duca et al. (2011) shows that lower interest rates and easy access to credit were the two critical drivers of the housing boom between 2000–07.

[33] It is a similar concept as the user cost of capital, which is the unit cost of capital asset use for a single period.

[34] For example, in Ontario, Canada, the Residential Tenancies Act 2006 clearly states that the annual increase in rent cannot exceed 2.5 per cent.

They argued that the LTV for first-time buyers, who are typically more sensitive to down-payment constraints, should be included in the house price equation as a proxy for access to credit. Christensen et al. (2011) showed that a policy ceiling on the LTV for residential mortgages can effectively mitigate the pro-cyclicality of the housing price and the mortgage financing activities. A relaxation in credit standards can pull up the price of housing by creating demand from previously non-qualified borrowers (see Andre (2016)). Fuster and Zafar (2015) found that the number of poorer households that are willing to buy a home increases when there is a relaxation in the down-payment requirement. Similarly, Cerutti et al. (2017) showed that credit conditions (according to various measures) improved the predictability of cross-country variations in house prices by an additional 10 per cent.

Apart from credit conditions, Droes et al. (2016) examined the validity of seven fundamental determinants of the housing market using historical data going back to 1900. The demand factors were GDP per capita, interest rates, population growth, the unemployment rate, and the share of the working-age population. On the supply side were new housing supply and construction costs. They found that the relative importance and statistical significance of these determinants changed from being more construction cost-led to being more income/credit-driven from the 1970s onwards. According to Andre (2016), a shock to the fundamental determinants, such as easier access to mortgages, can lead to an overshooting in house prices over an extended period. Caldera and Johansson (2013) argued that, in the long run, housing demand is mainly driven by the expected permanent income, demographics, and the user cost of housing.

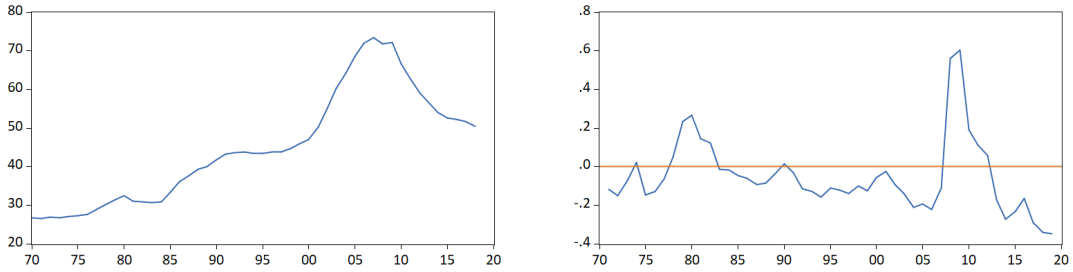
Mortgage debt

Schularick and Taylor (2012) created a database which traces the credit and money data between 1870 and 2008 for 14 developed countries. They found that, the trends for money and credit gradually decoupled after 1945. A rising trend for the credit-to-money ratio in many countries was witnessed. Using a probabilistic model, they concluded that the lagged domestic credit growth, after controlling various explanatory variables such as the broad money growth, was the best predictor for financial instability.

In most developed economies, mortgage debt is the most significant component on the liability side of the household balance sheet. In Fig. 3.8, the household mortgage level as a percentage of GDP went through two structural shifts — one in the early

1980s and another one in the early 2000s. These shifts are also well recorded by the credit conditions index[35] on the right. Credit standards have consistently been below the historical average since the mid-1980s. They tightened temporarily in the early 1990s, early 2000s and again in 2008 as a result of the economic recessions. According to Muellbauer and Williams (2011), time-series analyses of household debt remained relatively limited up until the financial crisis. The literature has only begun to flourish in recent years.

Figure 3.8.: Household liability for home purchase as a percentage of GDP (left) and credit condition index (right), US, 1970-2018



Source: BEA and OECD, own calculation

Wolswijk (2006) and Coletta et al. (2014) summarised a range of possible variables to explain the dynamics of household mortgage debt. The determinants often impact on the household debt position through various channels. Hence, the theory cannot give definitive coefficient signs for these variables. For instance, on the demand side, a higher disposable income can either increase or decrease the demand for mortgage debt. The net effect depends on whether the increase in income is used to repay debt or improve leverage.

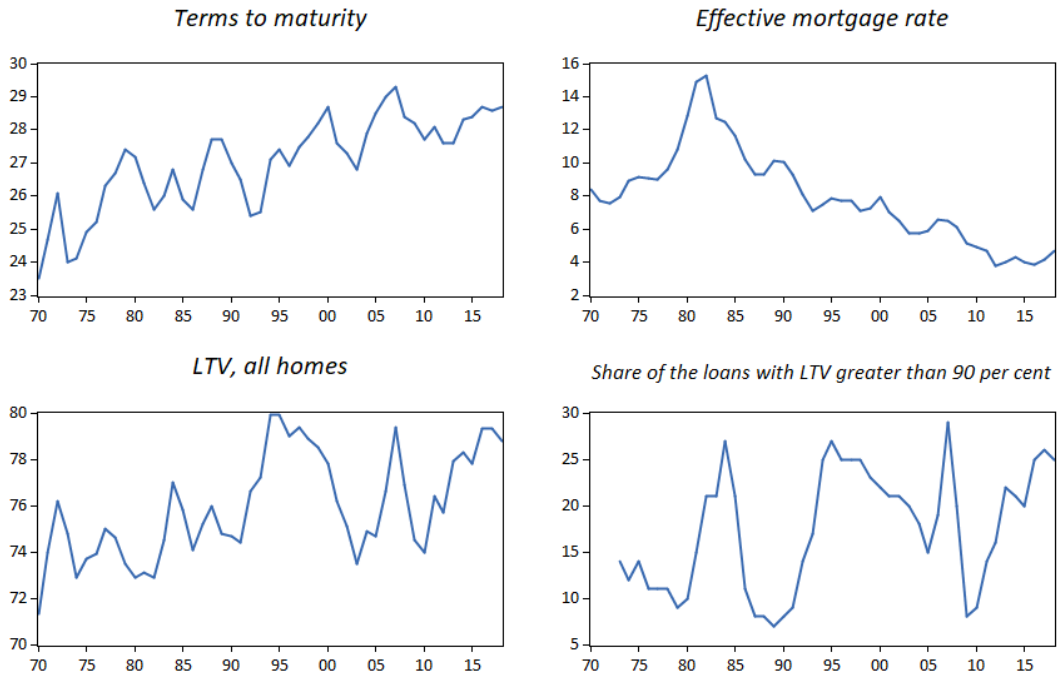
Similarly, Geiger et al. (2016) argued that the coefficient sign for the price of housing is likely to be time-variant depending on the down-payment requirement. When the requirement is low, perhaps due to credit relaxation, the collateral effect of the housing asset dominates, and an increase in house prices increases household demand for mortgages. In contrast, when the requirement is high, households can be deterred from borrowing.

As a sign of the ability of households to contract new debt, their level of financial

[35] See next subsection for a detailed description on the financial conditions index of Chicago Fed. Negative and positive values represent loose and tight credit conditions comparing with historical average respectively.

wealth can be positively associated with their mortgage debt level. However, when a house purchase is based on the investment motive, then the coefficient sign will again become ambiguous due to the substitution effect on holding other financial assets. Other factors, such as the cost of financing (i.e., interest rates) and demographics, may also affect household mortgage demand.

Figure 3.9.: Terms on conventional single-family mortgages, annual national averages, 1970-2018



Source: Federal Housing Finance Agency (FHFA), created by the author

On the supply side, the banking system has enough autonomy to determine the supply of mortgages both in the short and long run. Therefore, credit standards are the most critical factor in this regard. Cerutti et al. (2017) summarised several features of the US house finance market[36] as predictors of a credit boom. According to IMF (2011), the US housing finance market is among the least regulated in the world. Fixed-rate mortgages with a maturity of up to 30 years are the most common type of mortgage in the market. The dominance of Government Sponsored Enterprises (GSE), such as Fannie May and Freddie Mac, in the market, acts as a

[36]See Fig. 3.9 for the dynamics of various terms on conventional single-family mortgages in the US. The effective mortgage rate is the sum of the contract interest rate and the fees and charges amortized over a 10-year period.

significant hedge against interest risks. Additionally, the US is the only country that does not attach prepayment penalties[37] to fixed-rate mortgages, and the maximum LTV exceeds 100 per cent — amongst the highest in the world. The term to maturity is also five years above the world median level. As regards funding, the US is highly reliant on securitisation. The ratio between MBS and total residential loans has been as high as 64.1 per cent, whereas the second-highest—in the UK—is about 31.2 per cent.

Disney et al. (2009) studied the impact of house prices on the dynamics of household debt in both the US and the UK. Their data showed that households that have high LTV ratios (80–90 per cent) for mortgages are also likely to hold more unsecured and secured debt. However, a decline in outstanding mortgage liabilities was witnessed in the case of households with lower LTV ratios. The difference in the recourse agreement[38] between the two countries implies that US borrowers are more likely to have higher leverage positions during a house price boom. Similarly, when house prices fall, US borrowers are more prone to defaulting than their UK counterparts.

3.4.2. Model and data

As housing rents in the US are mainly market-driven, the rent-arbitrage model should closely reflect house price development (Muellbauer, 2012).

A range of control variables were introduced into the model based on the literature review. According to Oxford Economics (2016), various economic fundamentals affect house prices. In particular, rent and the user cost of housing are identified as key drivers.

The house price model is thus given by (3.15),

$$\Delta ln(hp_t) = \beta_0 + \beta_1 ln(hp_{t-1}) + \beta_2 ln(uc^h_{t-1}) + \beta_3 ln(rent_{t-1}) + \beta_4 ln(y_{t-1}) + \beta_5 cs_{t-1} + \beta_i control_{it-1} + \alpha_i \Delta \boldsymbol{sr_{it}} + \varepsilon^{hp}_t \tag{3.15}$$

[37] It is a fee that deters the borrowers from early repayments and provides some guarantee for the lenders to cover the related risks and the costs of processing the loan.

[38] Conforming mortgage borrowers in the US have non-recourse clauses, which effectively limit the down-side risks of falling house prices, as borrowers can end their debt obligation by walking away from their properties. Such benefits do not apply to UK mortgage borrowers.

where the long-run variables are in level with coefficients β and the short-run dynamics have α coefficients. The vector of short-run variables contains the same explanatory variables as specified for the long-run equation. All the variables are in real values using the consumption price deflator. The OECD provides the real house price index between 1970 and 2018 for all member countries. The base year is 2015, which is indexed at 100.

Oxford Economics (2016) explained how the rent-arbitrage model works in great detail. The uc^h_{t-1} term is the real user cost of housing. The data is the sum of the mortgage interest rate, adjusted for inflation and income tax, the depreciation rate, and the marginal property tax rate. The demand and supply of housing services are reflected by the changes in real rent ($rent_t$). Hence the stock of housing is not explicitly included in the model. The real user cost and the real rent data both come from the Federal Reserve's FRB/US model[39].

Although part of the income effects are captured by the development of housing rent, household income (y_t) can directly affect housing prices as well. With higher income, the household is expected to demand more housing service as well as higher rate of owner occupation. In the regression, the income data are either real GDP per capita or real household disposable income[40].

cs_t represents the US credit condition. There are various measures/indices available that measure the level of US mortgage lending standards. According to Li and Goodman (2015), four measures are frequently used: the Senior Loan Officer Survey (SLOS); the Home Mortgage Disclosure Act (HMDA) mortgage application denial rate; the Mortgage Bankers Association's (MBA) Credit Availability Index; and the median borrower's credit score. However, unfortunately none of the four measures can adequately test the effects of credit conditions prior to the GFC using a model with annual data. For example, the SLOS is unsuitable, because, although it has the most extended time series which dates back to 1990, between 2007 and 2015 the index was dis-aggregated into several mortgage categories. Without the relative weights, it is difficult to meaningfully synchronise the post-crisis data with the previous levels. In terms of the other three measures, they only became available from either the late 1990s or the early 2000s so they provide insufficient data to support the analysis of credit conditions prior to the crisis.

[39]It is a large-scale estimated general equilibrium model. See Brayton et al. (2014) for a brief introduction to the model.

[40]Both series are from the OECD household accounts

Given the drawbacks relating to the four measures identified by Li and Goodman (2015) in terms of their ability to support the necessary analysis of pre and post-crisis data, this chapter will use two alternative measures. One is the Chicago Fed's Adjusted National Financial Condition Index (ANFCI)[41] and the other one is the number of mortgages from the HMDA database. The former is a composite index of 105 indicators that cover the entire financial market between 1971 and 2018. The credit sub-component measures the willingness to lend and borrow. It is the weighted result of 35 indicators, which consists of the SLOS data, various yield spreads, and money supply measures. Therefore, it reflects the credit standard of the broader financial market not just the mortgage market. A zero value represents the historical average level. A negative value signals that the credit standard is below the historical average, while a positive value implies a higher-than-average credit standard. The construct inevitably results in a $I(0)$ time series. For it to satisfy the $I(1)$ requirement for the ECM estimation, a cumulative index is calculated so that the tightening and loosening of the credit standard follows the trend of the time series.

The number of newly issued mortgages for home purchases, as suggested by Gudgin et al. (2015), is a more direct measure of the credit standard of the mortgage market. The data records the number of mortgages originated for the purchase of one-to-four-family owner-occupied properties. The mortgage volume data between 1994 and 2017 are readily available from the HMDA database and the Federal Reserve Bulletin. The data can be extended further back to 1988 by applying the same percentage of conventional mortgage financed sales of newly built houses to the existing home sales data from the National Association of Realtors.

The mortgage liability model is given by (3.16),

$$\begin{aligned}\Delta mortl_t = \beta_0 + \beta_1 mortl_{t-1} + \beta_2 y_{t-1} + \beta_3 hp_{t-1} + \beta_4 cs_{t-1} \\ + \beta_5 R_{t-1} + \beta_i control_{it-1} + \alpha_i \Delta \boldsymbol{sr_{it}} + \varepsilon_t^{mortl}\end{aligned} \tag{3.16}$$

where the dependent variable is the real household mortgage liability, which is the nominal value adjusted by the consumption price deflator. The long-run relationship at levels contains real income (y_t), the real house price (hp_t), the credit standard

[41] ANFCI further reduces the degree of correlation between the financial measures and other economic activities in the NFCI.

index (cs_t) and the measures of various nominal interest rates (R). Additional explanatory variables, such as the working-age population and household financial assets, are included as control variables. The change of these variables is also tested for short-run dynamics.

The sign of β_2 is difficult to predict. The literature review suggests that an increase in real income can either result in a rise or a decline of household mortgage liability. It depends on whether the larger share of additional income is used for leveraging new debt or to pay off the outstanding mortgage liability.

β_3, however, is expected to reflect the positive feedback cycle effect between house prices and the outstanding mortgages described by Ryan-Collins et al. (2017). When the growth of mortgage lending exceeds the growth of supply in the housing market, then it is likely to produce demand-led inflation in house prices. At the same time, if house prices increase as a result of higher demand arising from a demographic shock[42], then a more substantial amount of mortgages must be issued to reflect this increase. When the rise in lending leads to higher profitability for banks, then it will enable the banking system to issue mortgages to more home buyers. Therefore, the two variables are endogenous to each other and will be simulated in a simultaneous equation system in sec. 3.6. The household mortgage liability data at current prices is sourced from the US Z.1 financial accounts.

The coefficient for the credit standard is expected to be negative. The credit standard sub-component of the ANFCI index reveals the lending standard in general. Relaxed lending practices in the mortgage market can be reflected either by the LTV ratio or the level of mortgage supply in the market. Hence the LTV ratio[43] is added as a control variable. A higher LTV ratio, which implies a lower down-payment requirement, enables households to borrow at a higher amount for each newly issued mortgage loan. The volume effect, on the other hand, is captured directly by the data on the number of new mortgages. With a higher volume of newly issued mortgages, the outstanding mortgage liability is likely to increase as well.

Apart from the leverage and volume effects, the cost of financing can also influence households' decisions on debt bearing. The nominal interest rate in the model is either measured by long-term interest rates or the effective mortgage interest

[42]For example, baby boomers after World War II were likely to purchase their first home between ages of 20 and 40.

[43]The data comes from the Monthly Interest Survey (MIRS) of the Federal Housing Finance Agency (FHFA) and Duca et al. (2016)

rate. The long-term interest rate is determined by the trading prices for 10-year US government bonds in the financial market as reported by OECD, while the effective mortgage rate comes from the FHFA, and is the sum of the contract interest rate and the fees and charges amortised over 10 years.

3.4.3. Results

In Tab. 3.2, the rent-arbitrage model[44] of house prices appears to provide highly significant results in the baseline regression - (1). Given the mortgage interest rate[45] is the predominant component of the real user cost, a negative coefficient between the user cost and house prices is in line with what the theory predicts. As a measure of the relative demand for housing services, the real rent is thus positively correlated with house prices. This holds true for both the short-run and long-run dynamics.

Control variables are introduced in regression (2)-(5). They are real household income and three credit condition measures: LTV ratio in regression (3), the total outstanding of non-agency mortgage-backed securities[46] in regression (4), and the number of mortgages in (5). Real disposable income per capita and real compensation per household are included as the measure for real household income. Neither is statistically significant.

Similarly, neither the average LTV nor the maximum LTV ratio for first-time buyers suggested by Duca et al. (2016) suggested by shows statistical significance for the period leading up to the crisis. The non-agency MBS, however, does indicate a positive impact on house prices in the short-run dynamics, but the size of the effect is relatively small. A 10 per cent increase in the outstanding amount is only associated with 0.3 per cent increase in house prices. The trans-Atlantic capital flows (see sec. 3.5) have strong preferences for these non-agency MBS compared to the surplus countries.

Having the number of mortgages as the credit standard measures further improves the adjusted R-square and the Durbin-Watson (DW) statistic. A DW value of 1.64 shows there is capacity to introduce other explanatory variables into the model. By

[44] All variables are in logarithm. Therefore the coefficients are elasticity measures.

[45] The mortgage rate closely correlates to the long-term interest rate, therefore, the long-term interest rate can impact house prices through the channel of the real user cost in the rent-arbitrage model.

[46] These are private-label MBS without guarantees from Government-sponsored enterprises such as Freddie Mac and Fannie Mae.

Table 3.2.: House price model with domestic factors only

	(1)		(2)		(3)		(4)		(5)	(6)
	1971-2006	**1971-2018**	**1971-2006**	**1971-2016**	**1972-2006**	**1972-2018**	**1981-2006**	**1981-2018**	**1993-2017**	**1981-2018**
Long-run (beta) relationships										
Constant	-0.744661***	-0.970830***	-0.612344***	-0.866701***	-0.174958	-0.107729	-1.560851**	-1.512975**	-0.810465	0.649162
	(0.0006)	(0.0000)	(0.0056)	(0.0006)	(0.7337)	(0.8375)	(0.0362)	(0.0300)	(0.4469)	(0.2654)
Real house price (-1)	-0.091577**	-0.203826***	-0.045819	-0.174048***	-0.100591*	-0.229214***	-0.096163*	-0.211027***	-0.127660*	-0.317867***
	(0.0342)	(0.0000)	(0.3410)	(0.0004)	(0.0701)	(0.0000)	(0.0784)	(0.0000)	(0.0926)	(0.0006)
Real per capita income (-1)			-0.087282	-0.072080						0.514096***
			(0.3189)	(0.4685)						(0.0035)
Demography (-1)										1.318755***
										(0.0045)
House stock (-1)										-1.275409**
										(0.0137)
Real user cost (-1)	-0.126933***	-0.162711***	-0.124490***	-0.160631***	-0.129909***	-0.161785***	-0.128868***	-0.201036***	-0.162633**	-0.206661***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0045)	(0.0000)	(0.0104)	(0.0007)
Real rent (-1)	0.311301***	0.484306***	0.360095**	0.533546***	0.360656***	0.567794***	0.507291**	0.646307***	0.354295	
	(0.0004)	(0.0000)	(0.0115)	(0.0006)	(0.0023)	(0.0000)	(0.0215)	(0.0010)	(0.189)	
Credit condition: number of mortgage (-1)									0.068662*	
									(0.0852)	
Credit condition: LTV (-1)					-0.172530	-0.260863*				
					(0.2643)	(0.0795)				
Credit condition: Non-agency MBS (-1)							-0.004251	-0.007057		0.008781
							(0.3993)	(0.1221)		(0.1888)
Short-run (alpha) relationships										
Δ Demography										0.416862
										(0.58)
Δ Real income			0.183773	0.090637						0.204586
			(0.2515)	(0.5931)						(0.4487)
Δ House supply										-1.025117*
										(0.085)
Δ Credit condition					0.052488	-0.155151	0.029012***	0.026741**	0.185084**	0.039333**
					(0.8054)	(0.3734)	(0.0061)	(0.0305)	(0.0129)	(0.0138)
Δ Real user cost	-0.085138**	-0.041808	-0.080434**	-0.042189	-0.074086**	-0.028802	-0.013274	-0.054382	-0.027938	-0.058596
	(0.0104)	(0.2074)	(0.0151)	(0.2386)	(0.0305)	(0.3948)	(0.7564)	(0.2452)	(0.6667)	(0.3171)
Δ Real rent	0.890887***	1.239565***	0.824935***	1.211617***	0.946966***	1.343250***	1.103253***	0.926504***	0.157090	
	(0.0003)	(0.0000)	(0.0041)	(0.0000)	(0.0003)	(0.0000)	(0.0016)	(0.0026)	(0.6666)	
Structural shift		-0.096977***		-0.095719***		-0.098723***		-0.105793***	-0.066655**	-0.087638***
		(0.0000)		(0.0000)		(0.0000)		(0.0000)	(0.021)	(0.0000)
Adjusted R-squared	0.675352	0.760340	0.691123	0.750877	0.682041	0.765494	0.840318	0.855593	0.905891	0.84998
Durbin-Watson statistics	1.030606	1.089486	1.104291	1.135908	1.089576	1.319866	1.857029	1.7203	1.637918	2.119109

P-values are in parenthesis
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively

including the number of mortgages, the real rent becomes statistically insignificant, although its coefficient sign remains positive. This seems to suggest that the relative demand for housing services is better represented by the tightening or loosening of credit availability in the domestic banking system. For a 10 per cent increase in the number of newly issued mortgages, house prices will increase by 1.8 per cent in the short-run and 5.4 per cent[47] in the long run.

Given the limited availability of mortgage volume data in the 1980s, the non-agency MBS is chosen as the credit standard measure in regression (6). The equation also explicitly spells out the factors that can potentially influence the supply (housing stock[48]) and demand (real income and demography) of housing services so that the real rent variable can then be replaced. On the supply side, that an increase in the total housing stock variable exerts downward pressure on house prices seems logical, and the negative relationships are statistically significant in both the short-run and long-run. On the demand side, real income is represented by the real compensation per household[49] and demography is represented by the number of households[50] as suggested by Oxford Economics (2016). As expected, both demand measures are not only positively correlated with house prices, but also significantly at a 1 per cent level in the co-integration equation. The estimated coefficients for the credit condition measures are consistent with the regression (4) with the growth of non-agency MBS positively associated with house prices, but the size of the impact is relatively trivial compared with the other independent variables.

The negative error correction coefficients across all the model specifications indicate convergence to the long-run equilibrium over time. The speed of adjustment ranges from -0.09 to as high as -0.3. The dummy variable is intended to account for the structural shift in the macroeconomic environment after 2008. It captures the impact of all the other macroeconomic variables that are not explicitly listed in the regression, such as the low interest rate environment, more scrutiny on banking regulation and shadow banking.

No statistically significant relationships were identified after replacing the real user

[47] The coefficients for the variables in levels need to be calculated by dividing the coefficient of the error correction term. For example, in this case, $\widetilde{\beta}_5(0.54) = \frac{\beta_5(0.07)}{|\beta_1(-0.13)|}$

[48] The data are from the US Census. Houses that are off the market are not included in the regression.

[49] The coefficient sign and statistical significance remain when the per capita real disposable income is used as an alternative.

[50] As a measure of housing demand, the number of households makes better sense than the general population level.

costs with the short-term and long-term interest rates, which implies that factors such as expected inflation and the depreciation rate also played a role in affecting house prices. This result is in line with the claims of Bernanke (2013) and Glaeser et al. (2012). While Bernanke (2013) argued that the US policy rates had little impact on rising house prices in the US before the crisis, Glaeser et al. (2012) found neither robust nor substantial effects from the long-term interest rate[51].

In Tab. 3.3, there are four regression models for the real value of the household mortgage liability and each model is tested under two separate periods. 2007 is a natural cut-off point as the US economy entered a full-blown financial crisis in 2008. Regression (1) provides a baseline result for comparison. Although the variables of interests mostly give the correct coefficient signs, the error correction term is not significant for the pre-crisis period, which makes it difficult to confirm convergence towards the long-run equilibrium. Three explanatory variables are included. The real house price is highly substantial across all four model specifications. Hence it reinforces the positive feedback effects between house prices and mortgage lending.

The real house price index is provided by the OECD[52], with the 2015 price (100) used as the base year. For the period between 1972 and 2017, a one unit rise in the real house price index was estimated to increase the mortgage debt liability by more than US$234 million in the long-run and more than US$522 million in the short-run.

[51]It only accounts for less than one-fifth of the rise in US house prices between 1996 and 2006.
[52]The average and median real house price in dollar terms is about 20 to 30 times the unit index value.

Table 3.3.: Mortgage liability model with domestic factors only

	(1)		(2)		(3)		(4)	
	1972-2007	**1972-2017**	**1972-2007**	**1972-2017**	**1981-2007**	**1981-2013**	**1981-2007**	**1981-2018**
Long-run (beta) relationships								
Constant	-10334.83***	-15808.64***	-15275.73***	-10377.30***	-45697.63**	-57090.84***	-11191.98**	-8402.113***
	(0.0005)	(0.0000)	(0.0021)	(0.0000)	(0.0149)	(0.0002)	(0.0176)	(0.0066)
Real houshold mortgage debt (-1)	-0.044218	-0.123277***	-0.121*	-0.050187	-0.185627***	-0.292585***	-0.129232*	-0.056651**
	(0.1978)	(0.0024)	(0.0783)	(0.114)	(0.0094)	(0.0000)	(0.0707)	(0.0319)
Real disposable income (-1)			0.000433	0.000136				
			(0.1659)	(0.6129)				
Real house price (-1)	192.1076***	234.5443***	259.9651***	187.8040***	319.7142***	437.1931***	253.0696***	177.7039***
	(0.0011)	(0.0045)	(0.0022)	(0.0004)	(0.0002)	(0.0000)	(0.0023)	(0.0001)
Long-term interest rate (-1)	-52.72123	416.9291*	-50.78361	-74.14891				
	(0.5935)	(0.0701)	(0.6389)	(0.6225)				
Unemployment (-1)							194.2742	118.4715
							(0.2248)	(0.5507)
Real financial wealth (-1)							-0.015755	-0.010536*
							(0.1033)	(0.0601)
Repayment rate (-1)					-334.4417	-777.9383**		
					(0.3629)	(0.0426)		
Credit standard: LTV_FT (-1)					377.5554**	503.3559***		
					(0.0434)	(0.0014)		
Credit standard: ANFCI (-1)	386.7067	-2762.657**	-1194.949	-136.4679			-3908.166**	-2120.927**
	(0.8406)	(0.0167)	(0.6003)	(0.8559)			(0.0223)	(0.0400)
Short-run (alpha) relationships								
Δ Real disposable income			-0.0000124	0.000106				
			(0.9933)	(0.9321)				
Δ Real house price	587.3530***	522.2217***	559.9117***	490.2917***	488.2298***	382.3353***	547.7251***	530.1949***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Δ Interest rate	-257.9353*	-364.9265	-226.7312	-410.6821**				
	(0.0847)	(0.2143)	(0.1596)	(0.0228)				
Δ Repayment rate					-2039.609***	-3225.262***	-1794.113***	-1552.401***
					(0.0055)	(0.0000)	(0.0030)	(0.0080)
Δ Unemployment							169.7429	160.2189
							(0.3520)	(0.4761)
Δ Credit condition	-4982.675***	-2244.069	-5554.174***	2162.085	129.7656			
	(0.0099)	(0.3123)	(0.0057)	(0.1726)	(0.3509)			
Financial crisis dummy				-6536.332***		-2442.949**		-3643.433***
				(0.0000)		(0.0374)		(0.0076)
Adjusted R-squared	0.946342	0.787673	0.946426	0.925431	0.951171	0.959834	0.95721	0.945175
Durbin-Watson statistics	1.684167	0.895822	1.58718	2.06435	1.370369	1.968807	1.378955	1.908849

P-values are in parenthesis
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively

The ANFCI credit subindex was negatively correlated with house prices before 2008, suggesting that a relaxation on credit access in the financial market, in general, leads to a more substantial accumulation of household mortgage debt. The unit measure is the standard deviation away from the historical average level. After including the post-crisis period, the index remains significant for the long-run relationship, but the significance level no longer exists once the structural shift dummy variable is introduced into the equation (see regression (2)). As an index for general financial market credit access, the ANFCI may not best reflect the development of the mortgage market, especially during the post-crisis period, when interest rates are low but access to mortgage lending is limited either due to a lack of confidence among

borrowers or the implicit deterrence by the banking sector.

The coefficients for the long-term interest rate, which is closely aligned to the actual mortgage rate, are primarily negative. However, most of the coefficients are statistically insignificant. One possible explanation is that the ANFCI credit index comprises various measures on bond spreads, so there might be an overlap with the effects of the long-term interest rate. No statistical significance was found for the long-term rate during the pre-crisis period.

The real income variable does not show any statistically significant or substantial impact on mortgage liability. For this reason, it was excluded from the regression (3) and (4). In regression (3), two alternative explanatory variables are added: the mortgage repayment rate and the maximum LTV ratio for first-time buyers. The mortgage repayment rate is calculated as the ratio between the mortgage service payments and the previous period mortgage liability. Therefore, a higher mortgage repayment rate inevitably exerts downward pressure on the total outstanding amount, as confirmed by the regression results in (3).

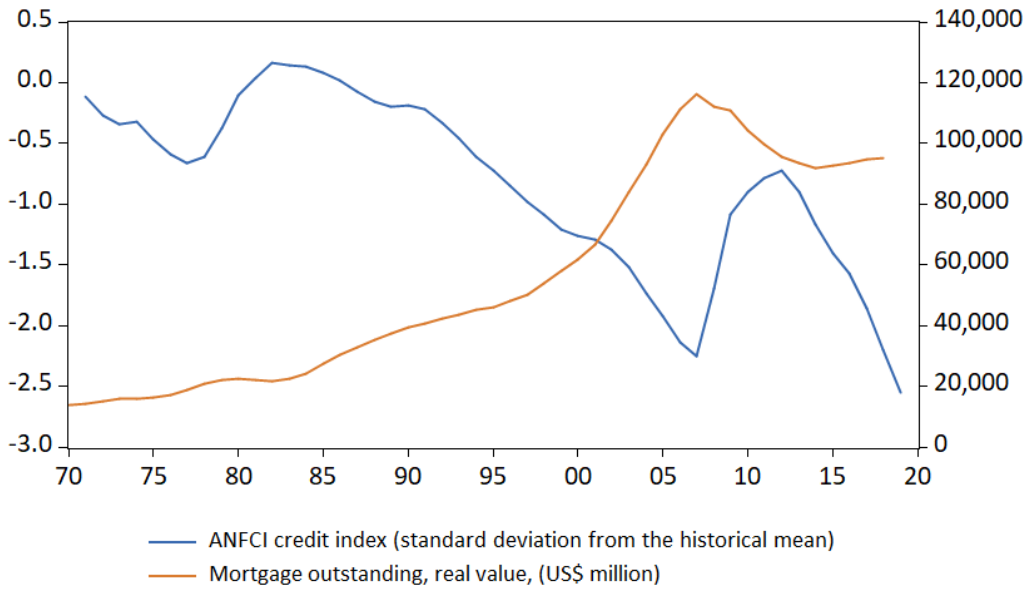
The LTV data for first-time buyers is from Duca et al. (2016)[53]. It is consistently above the average LTV ratio in the US mortgage market. Using the quarterly data and the rent-arbitrage framework, Duca et al. (2011) shows the maximum LTV ratio for first-time buyers had a significant and positive impact on US house prices before the crisis. However, such effects are not present in our house price model using the annual data. The LTV data appears to be positively correlated with mortgage lending instead, which will indirectly affect house prices through the positive feedback loop. The dummy variable is for the year 2008 only, but it neither adds much to the value of adjusted R-square nor makes any changes to the other explanatory variables.

Regression (4) introduces two additional control variables: real household financial wealth and the unemployment rate. They add limited explanatory power to the equation. Interestingly, the significance of the ANFCI credit index is proven to be time-variant. Since the 1980s, the credit access standard has been consistently below its historical average, while at the same time the level of outstanding mortgages gradually built up to its peak level in 2007. A tightening of the credit standard was also observed between 2007 and 2012. There has been strong correlation between

[53]The data is only available for a period between 1979 and 2013. An annual average is calculated using their quarterly LTV data. It thus satisfies our purpose to test its impacts on the US mortgage liability before the financial crisis.

the two measures since the early 1980s when the Reagan administration in the US, and the Thatcher government in the UK, both initiated a process of rapid financial liberalisation.

Figure 3.10.: Credit standard (left axis) versus mortgage outstanding (right axis), 1970 - 2018



3.5. The cause of the financial crisis: GSG or GFG?

3.5.1. Literature review

There are two differing hypotheses for the pre-crisis US mortgage backed securities boom – the trans-Pacific GSG hypothesis and the trans-Atlantic GFG hypothesis and the relative contribution of each phenomenon has been the subject of significant debate.

According to Bernanke (2013), after the 1997 Asian financial crisis, many emerging economies actively searched for safe global financial assets. The result led to the mass purchase of US agency bonds, which contained a significant proportion of the mortgage-backed securities (MBS) issued by Freddie Mac and Fannie Mae. Apart

from the direct purchase of safe long-term US assets, the GSG story also emphasises the role of falling interest rates and net capital inflows from abroad to explain the housing boom. Borio and Disyatat (2011) and McCauley (2019) argued that the rapid growth of two-way capital flows across the Atlantic was the key driver of private-label MBS[54]. Therefore, under this hypothesis the gross inflows from Europe should be seen as the primary suspect for the pre-crisis boom in MBS.

Historical studies of global imbalances[55] tend to present mixed evidence on the linkages between the current account position/net capital flows, as emphasised by the GSG hypothesis, and financial crises. The situation witnessed in the US in the 19th century serves as an excellent example to counter the key claims of the GSG story. Although Catão (2006) and Bordo et al. (2010) provide quantitative evidence for the negative economic consequences associated with the sudden cessation of capital inflows and external debt positions, it is still challenging to infer the impact of the gross flows using historical data. According to Bordo (2005), the pattern and the scale of gross flows and net flows among the developed economies were very similar before 1914. The two-way flows only became dominant from the 1980s onwards.

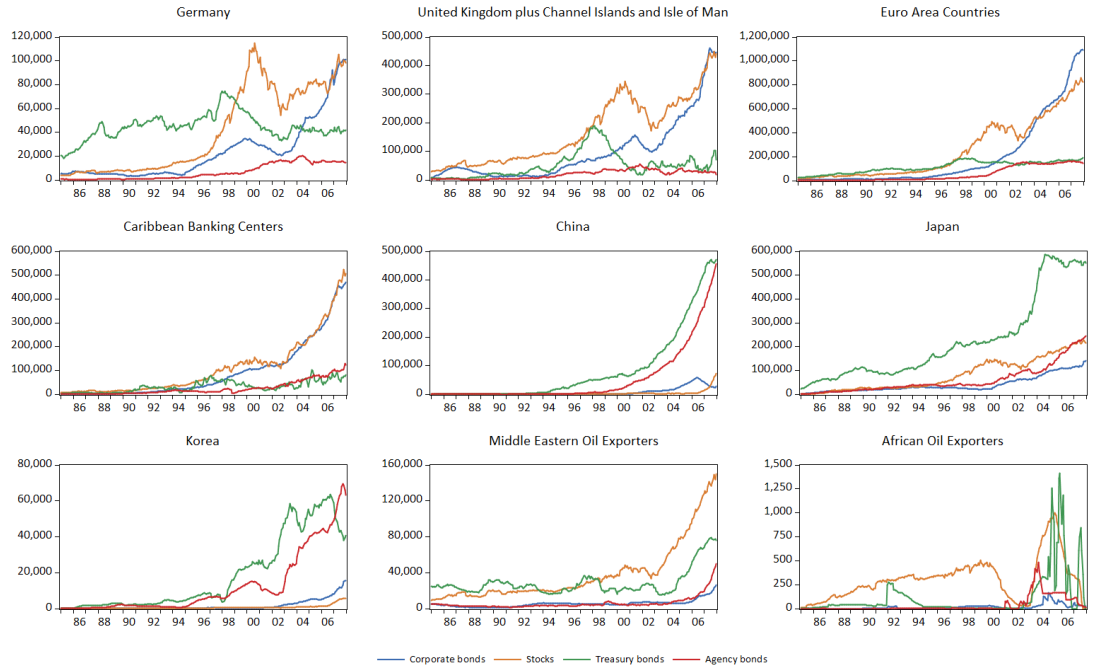
The empirical findings on the GSG and GFG hypotheses using data from the 1980s are also ambiguous. Bracke and Fidora (2008) used a structural VAR approach to underpin their investigation of this issue. They concluded that instead of the saving preference shock, the liquidity glut created by the positive monetary policy shock appears to be the more critical factor responsible for the worsening of the US current account position and the decline of long-term yields in the 1980s and the early 2000s.

Bertaut et al. (2012) noticed that the portfolio positions of international capital inflows into the US before 2008 were quite different across countries. While the GSG countries bought the majority of Treasury and agency bonds (trans-Pacific flows), the GFG countries tended to favour corporate bonds (trans-Atlantic flows), which consisted of most of the asset-backed securities (ABS) from the US private sector (see Fig. 3.11). The capital inflows from the GSG countries alone are not sufficient to explain the extent of the decline of the long-term rate and the bond yield spreads.

[54]These are securitised mortgages that do not conform to the same criteria set by the Government Sponsored Enterprises (GSE), such as the Freddie Mac and Fannie Mae.

[55]See section 2.3.3 for a detailed discussion on the economic history literature.

Figure 3.11.: Foreign holdings of the US long-term debt securities by countries and regions



Source: Bertaut and Judson (2014), created by the author

Favilukis et al. (2012) also agreed that while the drastic increase of foreign holdings of US Treasury and Agency bonds were responsible for the decline of the US long-term interest rate which coincided with the housing boom, the same low-interest rate environment also remained during the bust period. Having included both periods in their analysis, no significant empirical relationships between capital inflows from the GSG countries and house prices were identified. Instead they have shown that financial market liberalisation in the US made access to mortgage credit much easier for American households and this led to the decline of the risk premium for speculative housing investment.

Shin (2012) built a model to capture the role of international banks in financing the housing boom in the US. In the model, the increasing amount of capital flows intermediated through international banks repressed the risk premium of the ABS in the market and resulted in a lending and housing boom. Due to the bilateral nature of the trans-Atlantic capital flows between the US and Europe, the scale of the gross flows was disguised by the bilateral current account position. Unlike the US, the current account deficits in Spain and Ireland were more likely to be associated

with the housing boom in the domestic market, given there were less netting effects on banking flows. Kneer and Raabe (2019) studied how international capital flows affected the UK economy through the banking system. The foreign capital inflows into the UK led to more substantial credit growth to the corporate sector, mainly the construction sector, and other non-bank financial institutions before the GFC. No direct effects were identified for the UK household sector.

Justiniano et al. (2013) constructed a DSGE model to simulate both hypotheses. The model suggests that the combined gross inflows from the GSG and GFG led to a significant increase in house prices and household mortgage debt before the crisis. However, the GSG flow appears to be the more influential channel. The fall in spreads between borrowing and saving due to the rising intermediation by international banks (GFG flows) encouraged more borrowing and consumption from impatient agents but postponed the consumption of savers. The GSG flows, on the other hand, resulted in lower interest rates, which stimulated demand from both borrowers and lenders (savers).

Using the panel data analysis with 36 countries, robust relationships can be identified between the increase in real house prices and various indicators (Aizenman and Jinjarak, 2014). The panel data shows one standard deviation shock to the lagged current account to GDP ratio and the lagged domestic credit to GDP growth would result in a 5 per cent and 3 per cent appreciation in real house prices respectively. The same shock to the lagged value of house prices, as an indicator for the expectation formation, would result in a 10 per cent increase. These results seem to support the GSG and EM hypotheses. Punzi and Kauko (2015) used VAR analysis and discovered that foreign funding, in terms of both net and gross measures, had a positive impact on housing prices as well as the stock of domestic mortgages. Therefore, both the GSG and GFG stories are valid.

Yu et al. (2015) firstly adjusted periods of the data used by Bernanke (2010)[56] in the regression and confirmed the negative relationship between the monetary policy rate and house prices across OECD members countries was indeed statistically significant. They then focused on analysing the relationships between the level of foreign reserves in surplus countries and the policy rate and long-term rate in the US. Although the foreign reserves accumulated in East Asia seem to have impacted

[56]By having the dependent variable lagged behind the explanatory variables by one quarter, Bernanke was able to show a regression between the monetary rate and house prices with a R-sqaure of only 4.6 per cent and statistically insignificant estimator for the policy rate.

the long-term interest rate, no such statistical relationship was found with the policy rate.

After controlling the US monetary policy rate, Arora et al. (2015) still found the long-run negative relationship between excessive savings in the current account surplus countries and the US long-term interest rate (represented by the 10-year bond yield) using a VECM with quarterly data between 1982 and 2013.

Milcheva and Zhu (2016) found that the co-movement of house prices in developed countries were strongly associated with the level of exposure to cross-border capital flows. Capital inflows were channelled through international banks and contributed to credit growth in the domestic market. However, countries with relatively less-developed domestic mortgage markets, which are characterised by a high percentage of fixed-rate mortgage contracts, low maximum LTV and housing equity withdrawal (HEW), experienced much lower degrees of co-movement in the housing market. For example, given that HEW is not possible in Germany, although German banks are highly integrated with global capital markets, there was no housing boom in Germany similar to those in the US and the UK.

Apart from international capital flows, the long-term interest rate could be affected by other variables, which need to be included as control variables in the model. Howe and Pigott (1991) listed three fundamental determinants of the real long-term interest rate in the long-run from analysing US data from the mid-1970s to the early 1990s. The first determinant is the rate of return to capital derived from the production function. Higher productivity implies a higher rental price. The second and third determinants are market risk and regulation. A higher level of market risk or restrictions on lending (e.g. credit rationing policy) can raise the long-term interest rate. Idier et al. (2007) extended the analytical time horizon to the onset of the GFC. In the long-run equilibrium, the long-term rate follows the short-term rate and the government deficit variable, measured by gross debt to GDP ratio. In the short-run, the Purchasing Managers Index (PMI)[57] is used to reflect the general economic conditions of the US economy. Ciocyte et al. (2016) further extended the time series and proposed adding the potential GDP growth rate and a demographic variable into the analysis. The potential GDP growth rate serves as an indicator for the return of alternative investment, but it could be negatively associated with the risk premium. Therefore, the anticipated sign is ambiguous. The share of

[57]It is a composite index for the manufacturing sector, which is derived from the Institute for Supply Management survey data.

population aged between 20-39 was identified to be positively correlated with long-term bond yields and statistically significant. It is consistent with the predictions of the life-cycle theory, which suggests that the young working-age population is likely to borrow more than older age groups. Given the dependent variable is the nominal yields of the 10-year bonds, inflation measures were also included in the estimation.

3.5.2. Model and data

Gross capital flows

In order to examine the GSG and the GFG hypotheses, it is critical to have reliable sources for statistics on gross capital inflows into the US by different countries. To the best of our knowledge, there are three data sources which can provide such information. The first is the financial account data in the US Balance of Payments (BoP) statistics. The bilateral BoP data is available from the Bureau of Economic Analysis (BEA) under the US Department of Commerce. Both annual data and quarterly (not seasonally adjusted) data are available for use from 2003 onwards. Most of the countries and the economic regions of interest, namely, OPEC members, China and Japan for the trans-Pacific flows and the UK and the Eurozone for the trans-Atlantic flows, are well covered.

Avdjiev et al. (2018) highlighted that, in theory, gross flows should represent one-way capital flows. In practice, however, such data are not readily available. Most of the analyses on gross flows are actually net values of the US acquisition of liabilities[58] (gross inflows) and the acquisition of financial assets[59] (gross outflows), while the net capital flow is the difference of the two, which is reflected by the current account statistics. The net US incurrence of liabilities is the difference between the gross US acquisition of liabilities and repayments, while the net US acquisition of financial assets is the difference between the gross acquisition of financial assets and disinvestment. Therefore, 'gross' capital inflows and outflows can be either positive or negative.

Given the financial crisis began in 2007 and the bilateral BoP data is only available from the 1st quarter of 2003, it is difficult to generate any meaningful inferences for

[58]For example, securities that are issued by US residents and owned by non-residents will be recorded as a positive figure under the subcategory of portfolio investment liabilities.

[59]Similar to the net inccurence of liability, acquiring new inssuance of securities from non-US residents and owned by US residents, will then be counted as a positive figure under the subcategory of portfolio investment assets.

the causes of the 2007 - 2009 financial crisis, even with quarterly data. Based on the BoP data and various other data sources, Avdjiev et al. (2018) constructed a gross capital inflow database that provides quarterly data between 1996 and 2014 for 85 countries. However, their data is not yet published for public use. Although the panel data format is useful for analysing the impact of gross capital flows, the US data remains the focus of this chapter.

The Bank for International Settlements (BIS) has two databases that track international banking flows: the locational banking statistics (LBS) and the consolidated banking statistics (CBS). Both databases provide outstanding liabilities and claims positions of the counterparty banking sector against other reporting banks across the globe.

The LBS records international banking transactions based on the residence of counterparty and reporting banking offices, which is consistent with the BoP statistics and captures around 95 per cent of all cross-border banking activity. For example, when a US bank (the counter-party bank) lends to a borrower with a UK bank account, this adds to the outstanding claim position of the US banking system against the UK. Similarly, if a Chinese bank lends to US residents, it counts as the liability of US banks against Chinese banks. It should be noted that transactions among different offices in the world of the same banking group are not consolidated in the LBS database. It is the primary data source for cross-border bank credits that is widely used by GFG literature such as Avdjiev et al. (2016), Borio and Disyatat (2011), and Shin (2012).

Given the importance of banks' head-offices in decision making, focusing on the nationality of a banking group, instead of the location, can be useful in understanding the origin of financial instability. The CBS database consolidates intra-group transaction flows based on the residence of the banking group headquarters. The CBS statistics only report the claims and liabilities positions of the banks and their off-shore affiliates against borrowers or lenders that reside outside the bank's home-country economic territory. The intragroup transactions, regardless of the location of the offices, are excluded. For example, because HSBC is headquartered in London, the transaction flows between the head-office and its US subsidiaries are included in the cross-border transactions in the LBS, but consolidated in the CBS under UK banks. Therefore, the CBS data is more useful when analysing the international exposure of banks. The foreign claims of a particular bank could be cross-border

credits or local credits through its overseas branch (BIS, 2015).

The CBS statistics are reported under two different categories: the immediate counterparty approach and the ultimate risk approach. The difference can be best illustrated using an example. Assuming that there is a loan issued by an American bank to a Chinese multinational company, but the loan is actually guaranteed by a UK bank, in circumstances where the Chinese firm defaults on this debt obligation, the UK bank is liable to the American bank. Under the immediate counterparty approach, the loan adds to the US claims on China, while under the ultimate risk approach the US claims are placed on the UK instead.

There are no CBS statistics for China or OPEC members, which are crucial actors in the GSG hypothesis. Given this, use of the LBS data for our purposes seems more appropriate. LBS offers quarterly Chinese banking data going back to 1978. Although it should be noted that information for OPEC countries such as Saudi Arabia is only available until 2012.

The third data source for international capital flows is the US Treasury International Capital (TIC) System. Compared with the other two sources, the TIC database offers by far the most detailed picture of the US international portfolio investment data between the US and other countries. The data are available in annual, quarterly, or monthly formats. The TIC keeps tracks of the gross foreign (US) purchases of US (foreign) securities, derivatives, cross-border positions for banks, other financial institutions and non-financial institutions. The TIC serves as one of the primary sources for the international transaction statistics published by BEA.

The total securities can be grouped into two types: long-term securities (including equity and debt) and short-term securities (debt only). Both long-term and short-term debt securities can be further divided into treasury debt, government agency debt, and corporate debt. The long-term securities are recorded in greater detail under the "US Transactions with Foreigners in Long-Term Securities" database (FLTS henceforth), which provides monthly data on gross foreign purchases and sales of the US domestic and international long-term securities by country from January 1977. The net transactions of each type of security (i.e., gross purchases less gross sales of US securities by foreigners) are usually used for analytical purposes. The short-term securities are recorded by US banking data[60]. Inflows into the US by country

[60]The data include the cross-border positions of deposits, loans, and repo agreements reported by banks and other financial institutions.

and type, such as Treasury bills and negotiable certificates of deposits (CDs), are recorded under the liabilities to foreign-residents section (Bertaut et al., 2009).

Cross-border positions of non-financial institutions are collected quarterly by country on the TIC C forms. These forms distinguish between 'financial' claims and liabilities (such as deposits, short-term securities and loans) and 'commercial' claims and liabilities (such as accounts receivable or payable arising from import or export activities).

Furthermore, TIC offers comprehensive annual survey data on the cross-border positions of portfolio holdings of US securities from 2002 onwards. Before 2002, the surveys were conducted six times, in 1974, 1978, 1984, 1989, 1994 and 2000. Because the annual survey data are collected at the individual security level, the surveys provide important additional information on cross-border securities holdings, including greater detail on the types of securities held, their maturity structure and the face and market values of the individual securities (Cova and Natoli, 2019).

The capital flow data in our analysis mainly comes from the estimated TIC annual survey data provided by Bertaut and Judson at the Federal Reserve. They have estimated the monthly foreign residents' portfolio holdings of US securities by types and by countries/regions between 1985 and 2016. These data are still regularly updated by Bertaut et al. (2019). Majority of the capital flows in and out of the US are recorded under the portfolio investment[61]. To the best of our knowledge, the TIC annual survey is the most comprehensive and consistent source that is publicly available at the time of writing.

Long-term interest rate

The ECM model for long-term interest is given by (3.17),

$$\begin{aligned}\Delta R_t^l = \beta_0 + \beta_1 R_{t-1}^l + \beta_2 R_{t-1}^s + \beta_3 ln(B_{t-1}^i) \\ + \beta_i control_{it-1} + \alpha_i \Delta \boldsymbol{sr_{it}} + \varepsilon_t^{R^l}\end{aligned} \tag{3.17}$$

where B represents foreign holdings of bonds and $i = \{agency, corporate, treasury\}$ indicates the type of bonds. For example, $B^{treasury}$ represents the foreign holdings of the US Treasury bonds. Both the short-term interest rate (R^s) and the long-term

[61]The bank loans are under the other investment, which are better captured by BIS data.

interest rate (R^l) are in nominal values. Although the long-term rate of interest is widely regarded as a critical determinant for business investment, the continuous decline of the long-term rate since the 1980s cannot explain the boom and bust episodes seen in the US. The short-term rate refers to the money market rate. It is the market traded rate for the 91-day Treasury bills. The short-term rate is strongly influenced by the Federal Reserve and it is treated as an exogenous policy variable in the model. This assumption is also in line with the PK theory of interest rates (see Chapter 2 for more details).

The primary focus is β_3, which represents the impact of the total foreign holding of US bonds on the long-term interest rate. Given the trade surplus, surplus countries and European countries are distinct in terms of portfolio investment. The trade surplus countries became significant holders of Treasury bonds and agency bonds, whereas European countries focused on holding corporate bonds and stocks. The selection of control variables is based on the literature review.

3.5.3. Results

In Tab. 3.4, three measures of international capital flows are included into the house price regressions (1), (4) and (5) presented in Tab. 3.2 in order to identify any potential direct impacts.

The first measure is the current account to GDP ratio[62], which is a net capital flow measure. It is also the focal point of the GSG hypothesis. It is negatively associated with the real house price across all three regressions and presents statistical significance in three different periods: 1971-2006 (1_1), 1986-2006 (4_1)[63], and 1971-2018 (1_1). However, the size of impact is almost negligible. For example, between 1971 and 2006, 10 per cent decrease in the current account to GDP ratio results in a 0.8 per cent increase in house prices. It should be noted that the current account to GDP ratio in the US is a negative figure for most of the periods. Therefore, a 10 per cent decrease implies that the current account deficit widens and net capital inflows increases. This relationship fails to show robustness in regression (4_1) and (5_1) when measures on credit conditions are included.

[62]This is not in log form due to the presence of current account deficits (negative values).

[63]The starting date is chosen based on the availability of the portfolio holding data. It is useful to compare the impact on different capital flows by holding the period constant.

Foreign holding of agency bonds and corporate bonds are chosen as measures of portfolio flows into the US. Given that the trans-Atlantic and the trans-Pacific flows have very distinct patterns, the foreign holding of agency bonds mainly reflects the capital inflows from countries like China and Korea while the holding of corporate bonds largely represents capital inflows from Europe. Both variables are stock variables. Hence a positive coefficient for log form data implies that a percentage increase in the stock-holding of US bonds (i.e., an inflow of foreign capital) has a positive impact on house prices. Compared with the net flow measures, neither variables show the expected signs nor are they statistically significant in all of the regressions. Therefore, based on the portfolio positions, no direct impact from foreign capital inflows on house prices are identified.

Similarly, Tab. 3.5 adds three types of foreign bond holdings[64] to the regression (3) and (4) in Tab. 3.3. Coefficients for the holdings of all three types of bonds are ambiguous and are not statistically significant in either short-run or long-run relationships. In regression (3_1-3_3), the LTV ratio for first-time buyers seems to have interactions with these capital flow measures and becomes insignificant.

The estimated results for the long-term interest rates are given by Tab. 3.6. Regressions (1) to (5) focus on domestic factors only. Foreign holdings of three different bonds enter into the equation in regressions (6) to (9).

The short-term interest rate is positively associated with the long-run interest rate across all specifications. The short-term interest rate can be treated as an exogenous policy variable determined mainly by the Federal Reserve. The estimated results indicate that a 100 basis points (bps) increase in the short-term rate will lead to a rise, between 19 and 39 bps, in the long-term interest rate.

Like the rent-arbitrage model of house prices, the user cost of capital will be close to the real return of capital so that it has a significant positive correlation with the long-term interest rate in the short-run dynamics. The PMI, as an indicator of overall economic conditions, also shows the expected positive relationship with the long-term interest rate. However, its marginal impact is relatively small, ranging from 4 to 6 bps. There is no sound evidence for government debt and deficit variables to have significant effects over the long-term rate.

[64] Agency bonds contain large amounts of the MBS issued by Government-Sponsored Enterprises, such as Freddie Mac and Fannie Mae. Corporate bonds include the private-label MBS. US Treasury bonds are predominantly government bonds that have a maturity over a year.

The ANFCI credit index is used to capture the dynamics of credit conditions over time. The positive coefficients imply that a tightening of credit conditions will see an increase in the long-term rate. This measure only loses its statistical significance when the foreign holdings of agency bonds (7) and corporate bonds (8) are added into the equation. Given that a good share of corporate bonds are private labelled MBS, they have a close relationship with the credit index.

The foreign holding of the US bonds provides support to both the GSG and the GFG hypotheses. Using regression (6) as an example, a 10 per cent increase in the foreign holding reduces the long-term rate by 8.3 bps. In regression (9), the same size increase in the foreign holding of corporate bonds can result in a fall of 13.7 bps. However, the holding of corporate bonds only shows significance in the short-run dynamics. The data proves that both inflows from Asia and Europe contributed to the downward trend in the US long-term interest rate. Thus it can be concluded that international capital flows into the US have an indirect effect on house prices, mortgage lending and household consumption.

To sum up, the statistical significance of the domestic determinants in the housing price model and mortgage liability model remain robust after controlling the capital inflow measures. These portfolio inflows do not appear to have direct impacts on the housing price and mortgage liabilities in the US. However, both trans-Atlantic and trans-Pacific capital inflows appear to exert downward pressures on the US long-term interest rate. The trans-Pacific capital flows, mainly ended up in purchasing the US Treasury bonds, are found to have long-term effects as suggested by the GSG hypothesis. The negative effects of the trans-Atlantic capital inflows on the US long-term interest rate are estimated to be twice as large as the effects of the trans-Pacific capital inflows, but they are short-lived, which seems to be more consistent with the GFG story.

Table 3.4.: House price model with international capital flows

	(1_1)		(1_2)		(1_3)		(4_1)		(4_2)		(4_3)		(5_1)	(5_2)	(5_3)
	1971-2006	**1971-2018**	**1986-2006**	**1986-2016**	**1986-2006**	**1986-2016**	**1986-2006**	**1986-2016**	**1986-2006**	**1986-2016**	**1986-2006**	**1986-2016**	**1993-2017**	**1993-2017**	**1993-2017**
Long-run (beta) relationships															
Constant	0.046475	-0.470516*	-2.076852*	-1.623652	-2.801828*	-1.870242	-1.193946	-1.122008	-2.544916**	-1.364257	-2.621621*	-1.787722	0.040391	-1.733973	-1.488592
	(0.8157)	(0.0721)	(0.0663)	(0.2005)	(0.0518)	(0.1443)	(0.2756)	(0.3560)	(0.0301)	(0.2525)	(0.066)	(0.1458)	(0.9734)	(0.1972)	(0.304)
Real house price (-1)	-0.182132***	-0.262419***	-0.080966	-0.204921***	-0.093427	-0.203517***	-0.191192**	-0.258050***	-0.116137*	-0.253484***	-0.120890*	-0.250972***	-0.232457***	-0.154287**	-0.139275*
	(0.0000)	(0.0000)	(0.1821)	(0.0011)	(0.1505)	(0.0007)	(0.0129)	(0.0013)	(0.0566)	(0.0002)	(0.0912)	(0.0002)	(0.0079)	(0.0483)	(0.0798)
Real user cost (-1)	-0.117990***	-0.169418***	-0.192416***	-0.237239***	-0.174393***	-0.240232***	-0.058794	-0.226632***	-0.125381**	-0.232103***	-0.133684*	-0.269758***	-0.230029***	-0.179584***	-0.201225***
	(0.0000)	(0.0000)	(0.0041)	(0.0001)	(0.0085)	(0.0000)	(0.2478)	(0.0002)	(0.0454)	(0.0002)	(0.0773)	(0.0003)	(0.0005)	(0.0063)	(0.0016)
Real rent (-1)	0.211446***	0.427293***	0.667026**	0.6871**	0.882879**	0.768348**	0.485712*	0.601226*	0.782112**	0.632588**	0.814627**	0.795643**	0.303340	0.634292*	0.600431
	(0.0009)	(0.0000)	(0.0253)	(0.0384)	(0.0233)	(0.0303)	(0.0676)	(0.0579)	(0.0106)	(0.0426)	(0.0349)	(0.0217)	(0.3096)	(0.0667)	(0.1218)
Credit condition: number of mortgage (-1)													0.026123	0.033011	0.039241
													(0.5556)	(0.3554)	(0.2361)
Credit condition: Non-agency MBS (-1)							-0.005086	-0.002926	-0.022321	0.016020	-0.003281	0.029049			
							(0.7077)	(0.8324)	(0.3157)	(0.5502)	(0.9221)	(0.3337)			
International capital flow measures															
Net capital flows (-1)	-0.015441***	-0.009712**					-0.013494***	-0.004578					-0.010319		
	(0.0000)	(0.0109)					(0.0132)	(0.3995)					(0.1874)		
Foreign holding of agency bonds (-1)			-0.01813*	-0.010589					0.004407	-0.013077				-0.012315	
			(0.0723)	(0.3545)					(0.7694)	(0.5467)				(0.3406)	
Foreign holding of corporate bonds (-1)					-0.034178*	-0.019380					-0.017418	-0.044651			-0.021154
					(0.0786)	(0.2704)					(0.684)	(0.2621)			(0.2818)
Short-run (alpha) relationships															
Δ Credit condition							0.020176	0.032331	0.054078*	0.026892	0.035511	0.062175*	0.108021*	0.110404*	0.104735*
							(0.3337)	(0.3424)	(0.0555)	(0.4557)	(0.339)	(0.0656)	(0.0848)	(0.0644)	(0.0711)
Δ Real user cost	-0.015441***	-0.009712**	-0.04392	-0.083953	-0.002563	-0.047852	-0.020655	-0.052105	0.008890	-0.056459	-0.003268	-0.063601	-0.012560	0.013183	0.010330
	(0.0000)	(0.0109)	(0.3799)	(0.1616)	(0.9631)	(0.4247)	(0.6125)	(0.3694)	(0.8626)	(0.3787)	(0.9565)	(0.3297)	(0.8522)	(0.8579)	(0.8815)
Δ Real rent	-0.063699***	-0.027148	1.453031***	0.970966***	1.242007***	0.753973**	0.139016	0.753121**	0.761108*	0.813463**	0.819629	0.840475**	0.311897	0.423008	0.294420
	(0.0077)	(0.3927)	(0.0010)	(0.0079)	(0.0081)	(0.0380)	(0.6962)	(0.0307)	(0.0759)	(0.0265)	(0.1336)	(0.0363)	(0.5437)	(0.2895)	(0.471)
Δ Capital flow	-0.011707***	-0.012225***	0.042567	0.026779	0.065547	0.077967*	-0.014738***	-0.005140	0.054078*	0.026892	0.030190	0.038208	-0.001235	0.025163	0.060893
	(0.0026)	(0.0092)	(0.1357)	(0.4717)	(0.1158)	(0.0864)	(0.0102)	(0.4432)	(0.0555)	(0.4557)	(0.5122)	(0.4157)	(0.8982)	(0.5395)	(0.2509)
Structural shift		1.068828***		-0.111886***		-0.101622***		-0.101894***					-0.084742***	-0.080024***	-0.068137**
		(0.0000)		(0.0000)		(0.0000)		(0.0000)					(0.0049)	(0.0084)	(0.0366)
Adjusted R-squared	0.840826	0.803966	0.814711	0.841906	0.807235	0.859428	0.907701	0.862815	0.868341	0.868191	0.816553	0.871756	0.876304	0.875882	0.876532
Durbin-Watson statistics	1.831302	1.321774	2.278947	1.703367	2.158601	1.929896	2.588793	1.754683	2.628048	1.910896	2.107892	1.966982	1.645405	1.595311	1.462137

P-values are in parenthesis
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively

Table 3.5.: Mortgage liability model with international capital flows

	(3_1)		(3_2)		(3_3)		(4_1)		(4_2)		(4_3)	
	1986-2007	**1986-2012**	**1986-2007**	**1986-2012**	**1986-2007**	**1986-2012**	**1986-2007**	**1986-2016**	**1986-2007**	**1986-2016**	**1986-2007**	**1986-2016**
Long-run (beta) relationships												
Constant	-11190.51	-26606.73	-8078.560	-25052.82	-25499.52	-15654.41	-13935.25***	-15116.36***	-9544.391**	-9021.332***	-13470.67	-12551.21***
	(0.6809)	(0.2048)	(0.7518)	(0.3556)	(0.3945)	(0.5606)	(0.0052)	(0.0079)	(0.0348)	(0.0018)	(0.0046)	(0.0037)
Real houshold mortgage debt (-1)	-0.169004	-0.322272**	-0.186904	-0.209164**	-0.118106	-0.201413**	-0.132316**	-0.067394*	-0.150814**	-0.102869**	-0.127152	-0.086025*
	(0.2671)	(0.0214)	(0.1771)	(0.0351)	(0.3473)	(0.032)	(0.0386)	(0.0627)	(0.0318)	(0.0112)	(0.0512)	(0.0625)
Real house price (-1)	309.6730**	439.0241***	318.0289**	345.3808***	316.8639***	322.4942***	320.6660***	261.9098***	276.4488***	225.4884***	306.8426	234.6441***
	(0.0109)	(0.0000)	(0.0219)	(0.001)	(0.0072)	(0.0002)	(0.0005)	(0.0002)	(0.0008)	(0.0000)	(0.0004)	(0.0000)
Real financial wealth (-1)							-0.019808**	-0.001518	-0.025492*	-0.019102**	-0.018972	-0.002915
							(0.0249)	(0.8285)	(0.0963)	(0.028)	(0.0729)	(0.6368)
Repayment rate (-1)	-1023.991	-1689.627**	-879.0770	-1060.525	-614.9793	-1129.569						
	(0.2007)	(0.0295)	(0.1746)	(0.1124)	(0.4086)	(0.1115)						
Credit standard: LTV_FT (-1)	75.18723	279.1503	17.03677	219.4058	162.2652	138.5229						
	(0.7684)	(0.1920)	(0.9491)	(0.3822)	(0.531)	(0.547)						
Credit standard: ANFCI (-1)							-4974.405***	-1582.733*	-5249.478**	-3258.766***	-4585.244	-1639.677*
							(0.0076)	(0.0924)	(0.041)	(0.0035)	(0.0265)	(0.0667)
International capital flows (beta)												
Treasury bonds (-1)			0.106862	0.000628					0.027311	0.1174		
			(0.379)	(0.9934)					(0.8066)	(0.1128)		
Agency bonds (-1)					-0.195624	0.15734					-0.223178	0.011571
					(0.6448)	(0.721)					(0.3525)	(0.9695)
Corporate bonds (-1)	-0.013144	-0.018878					-0.163709	-0.160540				
	(0.9552)	(0.9154)					(0.2607)	(0.3797)				
Short-run (alpha) relationships												
Δ Real house price	452.7593***	327.5347***	457.8687***	417.0876***	484.5586***	439.49***	496.1619***	471.4094***	509.9463***	445.5266***	498.0148	480.3162***
	(0.0003)	(0.0025)	(0.0002)	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Δ Repayment rate	-2705.607***	-3728.400***	-2762.161***	-3352.109***	-2302.426***	-2817.966***	-2492.106***	-3007.731***	-2304.482***	-2924.649***	-2335.075	-2677.078***
	(0.0023)	(0.0002)	(0.002)	(0.0011)	(0.0053)	(0.0035)	(0.0006)	(0.0009)	(0.0014)	(0.0006)	(0.0013)	(0.0023)
Δ Credit condition	-114.6471	30.26363	-103.4340	-62.66329	-95.80668	-102.3391						
	(0.5997)	(0.9023)	(0.6363)	(0.8169)	(0.6296)	(0.6642)						
International capital flows (alpha)												
Δ Treasury bonds			0.146268	-0.158653					-0.070520	-0.023023		
			(0.3645)	(0.3081)					(0.7383)	(0.8672)		
Δ Agency bonds					-0.61697	-0.528227					-0.239725	-0.329383
					(0.1776)	(0.2103)					(0.5257)	(0.4563)
Δ Corporate bonds	0.019111	0.319921					-0.042373	0.045297				
	(0.9364)	(0.1356)					(0.7883)	(0.7122)				
Financial crisis dummy		1030.346		-1591.315		-4358.844		-2149.141		-4119.206***		-4372.776**
		(0.6389)		(0.3623)		(0.0579)		(0.1397)		(0.002)		(0.0285)
Adjusted R-squared	0.959344	0.970169	0.96304	0.964308	0.965604	0.967318	0.973452	0.967357	0.971227	0.970116	0.973261	0.966629
Durbin-Watson statistics	1.429457	2.311069	1.537552	2.38306	1.479084	2.669304	1.496824	2.41437	1.423184	2.331591	1.573438	2.644046

P-values are in parenthesis
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively

Table 3.6.: Long-term interest rate model with international capital flow

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	1986-2016								
Long-run (beta) relationships									
Constant	0.711291**	-2.200833	1.352936	3.836295**	1.852354***	11.63897**	6.307313	11.8521***	10.32437***
	(0.0439)	(0.5189)	(0.6118)	(0.0397)	(0.0002)	(0.0106)	(0.1102)	(0.0026)	(0.0068)
Long-term interest rate (-1)	-0.339231***	-0.381594***	-0.439122***	-0.622529***	-0.482974***	-0.912902***	-0.619288***	-0.772266***	-0.771248***
	(0.0061)	(0.0072)	(0.0002)	(0.0012)	(0.0000)	(0.0002)	(0.0009)	(0.0000)	(0.0001)
Short-term interest rate (-1)	0.237179**	0.186607*	0.275253***	0.296241***	0.310239***	0.387907***	0.28715***	0.304022***	0.336691***
	(0.0196)	(0.0607)	(0.0019)	(0.0008)	(0.0002)	(0.0001)	(0.0003)	(0.0000)	(0.0000)
User cost of capital (-1)		21.33676							
		(0.2668)							
Credit condition: ANFCI (-1)		0.587554**	0.417495**	0.69057**	0.507613***	0.570855***	0.028114	-0.0101	0.44589***
		(0.0114)	(0.013)	(0.0115)	(0.0025)	(0.0006)	(0.9445)	(0.9556)	(0.001)
PMI (-1)			0.003387						
			(0.9449)						
Government debt (-1)				-0.017247					
				(0.1893)					
Potential GDP growth (-1)									
International capital flows (beta)									
ln(Treasury bonds (-1))						-0.830437**			-0.746672**
						(0.0268)			(0.0175)
ln(Agency bonds (-1))							-0.513023		
							(0.2302)		
ln(Corporate bonds (-1))								-0.969277***	
								(0.0068)	
Short-run (alpha) relationships									
Δ Short-term interest rate	0.371564***	0.246908***	0.338645***	0.296241***	0.396751***	0.363127***	0.389417***	0.392391***	0.381628***
	(0.0002)	(0.0085)	(0.0034)	(0.0008)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Δ User cost of capital		72.02632***	50.89193***	42.72543***	47.32344***	26.76816*	34.46249**	22.50214*	24.8996**
		(0.0016)	(0.0003)	(0.0038)	(0.0004)	(0.0526)	(0.0218)	(0.0441)	(0.0328)
Δ Credit condition: ANFCI		-0.643918							
		(0.3545)							
Δ PMI			0.063147**	0.049768***	0.058998***	0.041215***	0.050229***	0.042566***	0.04295***
			(0.0364)	(0.0053)	(0.0002)	(0.006)	(0.0017)	(0.0006)	(0.001)
Δ Government debt				0.003149					
				(0.8930)					
Δ Potential GDP growth					-0.533799**	-0.339664	-0.664123**	-0.765284***	-0.328642*
					(0.027)	(0.1317)	(0.0135)	(0.0006)	(0.0829)
International capital flows (alpha)									
Δ ln(Treasury bonds)						0.306051			
						(0.6491)			
Δ ln(Agency bonds)							-0.790483		
							(0.2464)		
Δ ln(Corporate bonds)								-1.817919***	-1.36898***
								(0.0007)	(0.0071)
Adjusted R-squared	0.419794	0.638907	0.801122	0.8088	0.836417	0.86421	0.841088	0.91312	0.905286
Durbin-Watson statistics	2.119903	2.071381	1.600591	1.518027	1.836852	1.665538	1.530531	2.531568	2.224998

P-values are in parenthesis
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively

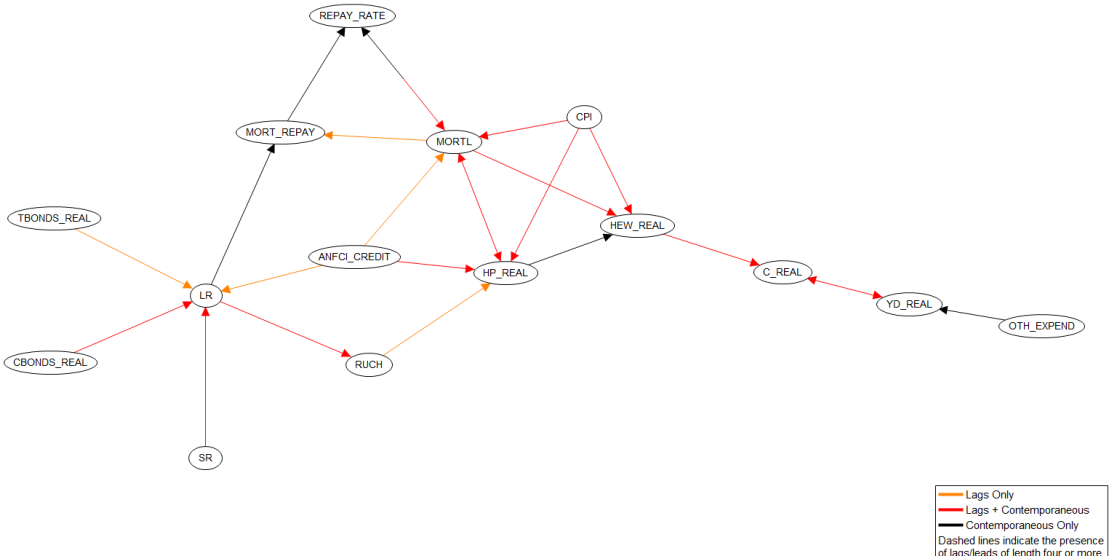
3.6. A partial equilibrium model - USMOD

Based on the empirical observations, a partial equilibrium model, USMOD, is formulated to simulate different scenarios for the US economy by shocking both exogenous variables such as the capital inflows and monetary policy rate. A simplified model structure[65] is given by Fig. 3.12. The dynamics of the four variables of interest, namely the real household consumption, real house prices, the long-term interest

[65] Double-headed arrows indicate two-way interactions. The variables that have no arrows pointing to them are exogenous variables in the model, which are subject to shocks for scenario analysis. For example, the short-term interest rate (SR) is an exogenous variable by design, as it only links to long-term interest rate (LR), but no other variables in USMOD would cause the SR to change.

rate and mortgage liabilities, are endogenous to each other. The two-way interactions cause difficulty in measuring their relative importance in terms of economic impacts. The partial equilibrium model is thus useful in capturing both direct and indirect effects from these variables.

Figure 3.12.: Model structure of USMOD



Source: created by the author

In the model, there are four core equations, which correspond to the four variables that have been discussed extensively in previous sections:

1. **Household consumption -** Equation 2_2 from Tab. 3.1 is chosen without any modifications. Two additional equations are added for household consumption. The first is for HEW, equation (3.20), to establish the linkage with mortgage liabilities and the second is for household disposable income to reflect the circular flows between consumption and income.

2. **House price** - Equation 4 in Tab. 3.2 is modified by including mortgage liabilities as an explanatory variable to reflect the reinforcing effects between house price and mortgage lending as described by Ryan-Collins et al. (2017). The credit condition variable is replaced by the ANFCI credit index, which is also important to the dynamics of long-term interest rate and mortgage liabilities. It is estimated using data between 1970 and 2017.

3. **Mortgage liabilities** - Equation 4 from Tab. 3.3 is included to model the dynamics estimated using data between 1980 and 2017. Given the mortgage

repayment rate is one of the explanatory variables in the mortgage liabilities equation. An equation for the mortgage repayment (3.19) is added to capture the two-way interaction.

4. **Long-term interest rate** - Equation 2 from Tab. 3.6 is modified by adding both foreign holdings of the Treasury bonds and corporate bonds. The estimation shows that the foreign holdings of Treasury bonds appear to have long-run effects and the holdings of corporate bonds only have short-run effects. Also, the long-term rate is now linked to the real user cost of housing in (3.18), which provides one more indirect channel[66] for the capital flows to influence house price.

The following paragraphs provide more information on the newly added equations in the baseline model. They are estimated using simple regressions, but have very high explanatory power in general during the sample periods. Their role is not to establish causation, but to provide vital linkages among the four core variables in the model.

The USMOD features the main findings in the empirical analysis. International capital flows, neither the trans-Pacific nor the trans-Atlantic flows, had a significant direct impact on US house price and the accumulation of mortgage liabilities. However, the findings did show there is an indirect channel. In particular, both sources of capital inflows, in the form of foreign holdings of US securities, exerted downward pressure on the US long-term interest rate (R^l). The US data suggest that there is a strong co-movement between R^l and mortgage rate R^{mort} during the period under consideration in this study (see Fig. 3.13) and the mark-up between the two rates also remains reasonably stable.

For simplicity, we replace R^{mort} with R^l, in (3.18) of the real user cost of housing, uc^h to establish the endogenous relationship between international capital flows and house prices. It is a simplified version of the US/FRB equation without explicitly spelling out the marginal federal income tax rate[67]. The uc^h is thus the sum of the depreciation rate (R^{delta}), the real long-term interest rate, and the marginal property tax rate (TR^{prop}). The real long-term interest rate is represented by two

[66] The other channel comes from the reinforcing effect from the mortgage liabilities. The mortgage liabilities are influenced by repayment rate and that is indirectly determined by long-term interest rate.

[67] It is implicitly captured by the coefficients of the long-term interest rate and the marginal property tax rate.

Figure 3.13.: US mortgage rate and long-term interest rate, 1970 - 2018

Source: OECD

components: the nominal rate R^l and expected consumer price inflation, π^{ex}.

$$\begin{array}{lccccccc} uc^h = & 1.74 & R^{delta} & +0.79 & R^l & -1.11 & \pi^{ex} & +0.69 \quad TR^{prop} \\ & (0.00) & & (0.00) & & (0.00) & & (0.00) \end{array} \tag{3.18}$$

Using data between 1970 and 2017, the estimated equation has an adjusted R-square of 95.2 per cent and all four coefficients are highly significant, base on the p-values in the brackets[68].

As expected, by holding the other explanatory variables unchanged, a decline of 100 bps in the long-term interest rate would result in a drop of 79 bps in the real user cost of housing. It, in turn, increases the demand for housing as investment.

The US mortgage liability, $MORTL$, model finds no direct linkages with either the US long-term interest rate or international capital flows. However, mortgage liabilities can be influenced by both factors through the circular causation with house

[68]The resulted p-values appear to be even less than 0.0000, hence they are limited to two decimals only. The same principle applies to the other reported p-values.

prices and the repayment rate. Before the GFC, the housing boom not only required a higher average mortgage amount but also increased the demand for mortgages to meet the rising investment demand for housing.

At the same time, the persistent decline in the long-term interest rate also lowered the mortgage repayment rate, which further accelerated the accumulation of mortgage liabilities. The mortgage repayment rate in the mortgage liability model is the ratio between mortgage debt service payment and the total mortgage liability. The debt service payment is estimated using the US long-term interest rate, a proxy of the mortgage rate, and the previous level of household mortgage liability. The log-linearised equation (3.19) offers a good representation of the mortgage payment data.

$$\begin{array}{lccccc} ln(MORT^{payment}) = & 0.16 & ln(R^l) & +0.82 & ln(MORTL_{-1}) \\ & (0.00) & & (0.00) & \end{array} \tag{3.19}$$

Using data between 1980 and 2017, the estimated equation has an adjusted R-square of 98.8 per cent and both coefficients are significant at 1 per cent level, base on the p-values in the brackets.

Both house prices and household mortgages strongly influence HEW, which in turn has a significant impact on household consumption and GDP. As mentioned in sec. 3.3, the HEW proxy is derived using the method proposed by Belsky (2004). It is the difference between the changes in total mortgage liability and the newly added housing wealth valued at the current level of average house prices,

$$HEW = \triangle MORTL - (h^{sales} \times HP^{average}) \tag{3.20}$$

where h^{sales} is the house sales and $HP^{average}$ is the nominal average house price, which is linked to the real house price through the consumer price deflator in the model.

In (3.21), the household real disposable income[69] is also endogenous to real household consumption, the previous level of financial assets, and real weekly earnings.

[69] A trend variable and a dummy variable for the year 2012 are also included to provide a better fit with the data.

It enables the model to capture the feedback effect on household income due to consumption-led GDP growth.

$$\begin{array}{lccccccc} yd^{hh} = & 0.55 & c^{hh} & +2.86 & fa_{-1}^{hh} & +64.17 & wage^{wk} \\ & (0.00) & & (0.01) & & (0.00) & \end{array} \tag{3.21}$$

Using data between 1979 and 2017, the estimated equation has an adjusted R-square of 99.9 per cent and all coefficients are significant at 1 per cent level, based on the p-value in the brackets. It should be noted that yd^{hh} will also be influenced by other expenditures based on the national accounting identity[70].

After solving the baseline model, four exogenous variables that are critical in verifying the claims of the three hypotheses discussed extensively in the previous chapter are selected to provide further quantitative evidence for our analysis. The four exogenous variables are the foreign holding of US Treasury bonds, the foreign holding of US corporate bonds, credit condition index and short-term interest rate.

We first conduct an external shock of US$100 billion on the foreign holding of US Treasury bonds and corporate bonds, respectively between 2003 and 2016. The simulation enables us to explore the transmission mechanisms of the trans-Atlantic capital inflows and trans-Pacific capital inflows within the US economy.

In Fig. 3.15, the charts in blue are the simulations for a US$100 billion lower foreign holding (mainly by GSG countries) of US Treasury bonds compared with the baseline model, while the charts in red are the results for a US$100 billion fall in the foreign holding (mainly GFG countries) of corporate bonds. The resulting patterns are quite distinctive between the GSG scenario and GFG scenario.

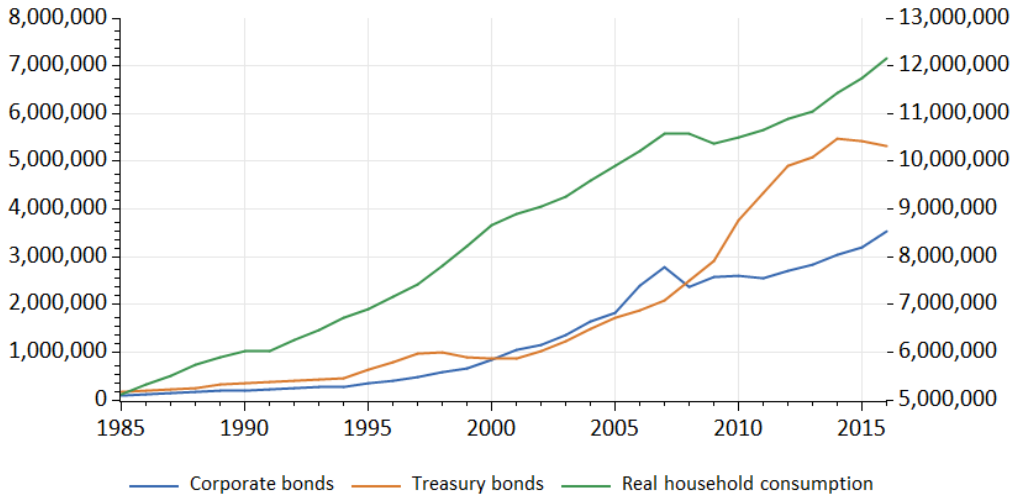
In the GSG scenario (in blue), capital inflows come through the holding of Treasury bonds. By holding less Treasury bonds, the long-term interest rate increases above the baseline level throughout the simulation periods. As discussed, the rise in the long-term interest rate has an indirect impact on house prices and mortgage liabilities. Relative to the baseline, house prices are lowered due to the increase in the real user cost of housing. Mortgage liabilities also decline as a result of the higher repayment rate required to service the debt. Both house prices and mortgage liabilities are the two crucial factors that determine HEW, which in turn exerts downward

[70]This exogenous linkage is represented by OTH_EXPEND in Fig. 3.12.

pressure on real household consumption.

The GFG scenario (in red) focuses on corporate bonds. The fall in the holding of corporate bonds has a more substantial immediate impact on the US long-term interest rate, but the effect is short-lived. The long-term interest rate quickly returns to the baseline level. While the house price recovers relatively quickly after the initial decline, it remains below the baseline level even in 2016. Comparing to the GSG scenario, the decline in household consumption is relatively mild, but shows little sign of recovery over the medium term. The response of mortgage liabilities seems more sluggish due to the simultaneous effects with the repayment rate. The dynamics of the repayment rate closely follow the long-term interest rate, as the relative position between 2007 and 2013 has been relatively stable, the mortgage liability stays below the baseline level for an extensive period.

Figure 3.14.: Foreign holding of the US Treasury bonds and Corporate bonds, 1985-2016, US$ millions

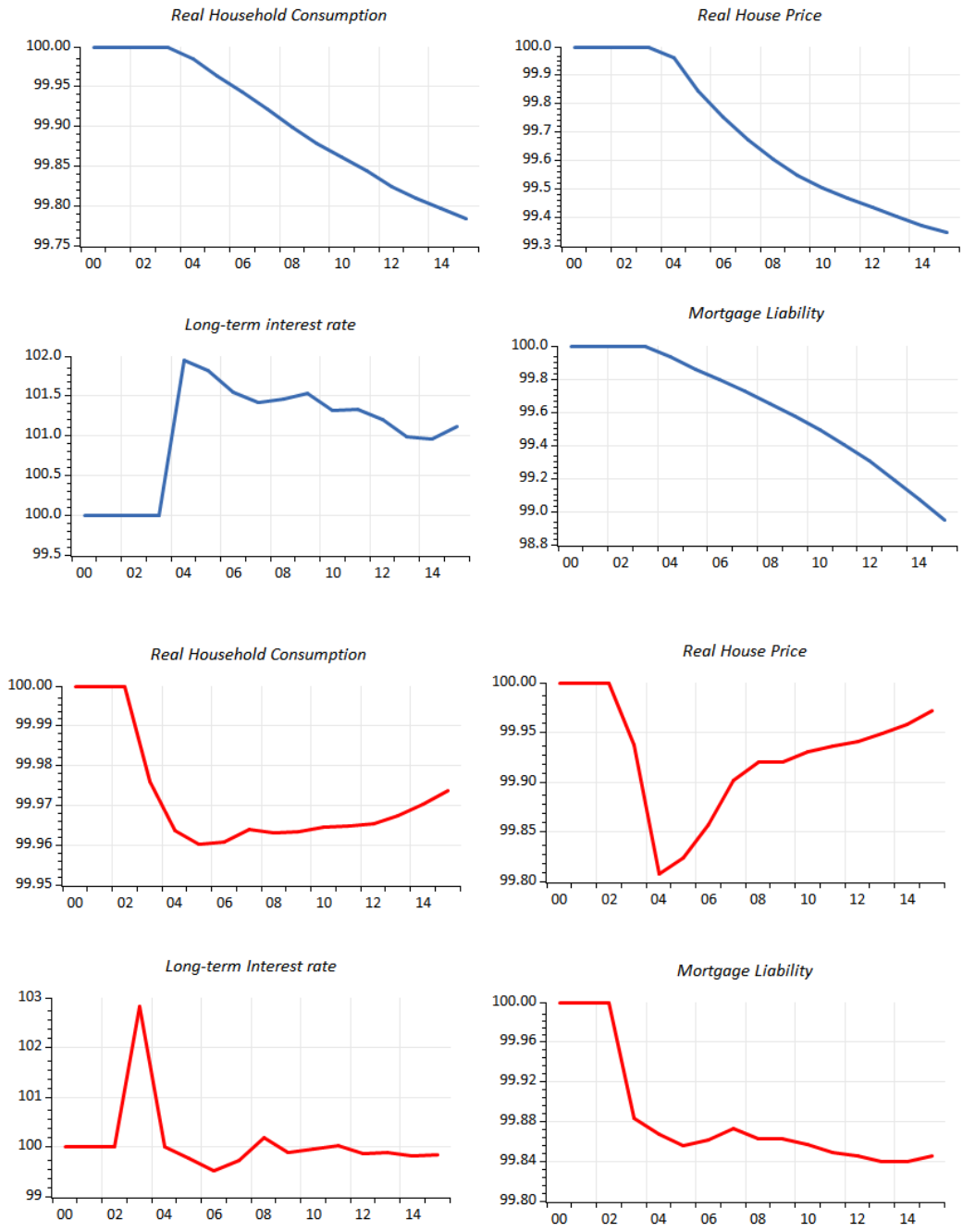


Source: Federal Reserve and Bertaut and Judson (2014), created by the author

Combining the simulation results and the empirical data observed in Fig. 3.14, we find that the foreign holding of corporate bonds was consistently higher than Treasury bonds and it increased particularly quickly before the GFC. Between 2007 and 2008, there was a reduction of over US$400 billion in the holding of US corporate bonds, which would have a similar but much more substantial impact as shown by the GFG scenario. The result is evident in the household real consumption data.

The holding of US Treasury bonds works in the opposite direction. As the GSG countries continued to purchase more US Treasury bonds, even during the crisis period, the capital inflows actually mitigated the negative impacts from the collapse in the holdings of corporate bonds.

Figure 3.15.: US$100 billion less treasury bonds (in blue) and corporate bonds (in red) versus baseline



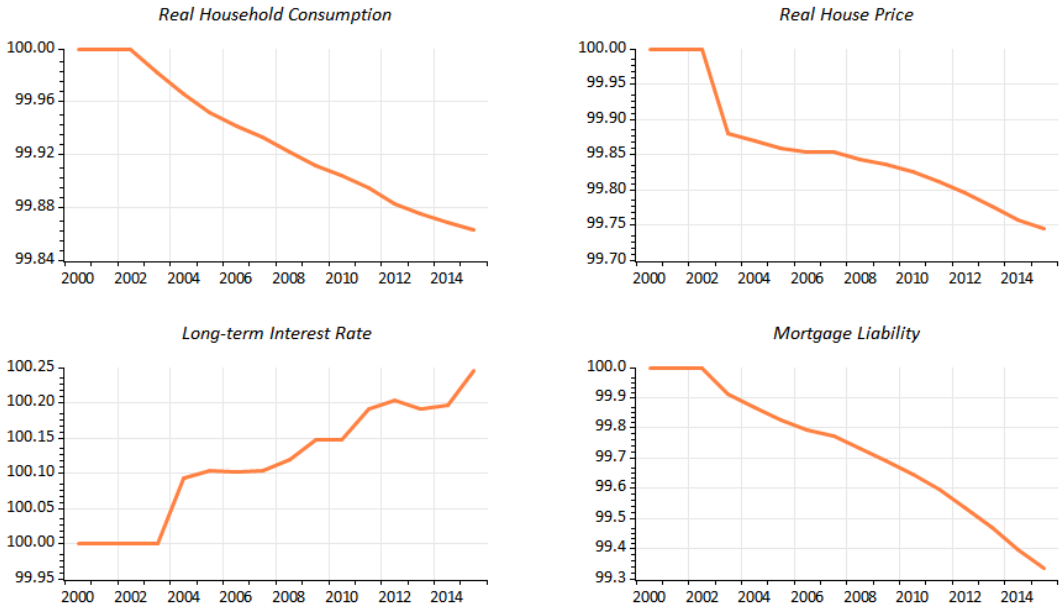
However, both the GFG and GSG countries were responsible for the persistent fall in long-term bond yields, which facilitated the credit and housing boom observed in

the US during the pre-crisis period.

In Fig. 3.16, we engineered a supply-side shock on mortgage lending which adds 0.05 to the accumulated ANFCI credit index[71] between 2003 and 2016. It implies that the credit conditions are relatively tighter by an average of 4 per cent during the simulation period comparing to the baseline scenario. Fig. 3.12 shows that the index can impact house prices and mortgage liabilities through two channels: a direct impact and a secondary impact through R^l.

In the model, the credit index is negatively correlated with house prices in the short-term dynamics and is negatively correlated with mortgage liabilities in the long-run cointegration relationship. Therefore, a tightening in mortgage lending (e.g. lower LTV ratio or less issuance of new loans) will unambiguously result in a fall in house prices and mortgage liabilities.

Figure 3.16.: Credit shock, tightening standards on mortgage loan, 2003-2016



Given that a higher long-term interest rate usually indicates tighter credit condi-

[71] A positive/negative value in the original ANFCI credit index indicates a tighter/looser than historical average condition in terms of credit access. It is measured as weighted sample standard deviations. Its average value between 2000 and 2007 was -0.13. After the transformation, the variations around the historical mean (0) are accumulated, the signs of the index are no longer indicative regarding the dynamics of credit condition. Therefore, a downward/upward trend in the index indicates a relaxation/tightening of credit standard comparing with the previous period.

tions, there is a positive correlation between the two in the long-run relationship. This is why the real house price constantly remains below the baseline level, after the initial fall. Together with the direct impact on house prices and mortgage liabilities, a lower level of household consumption is observed.

As a result, according to Fig. 3.10, a continuous relaxation of credit standards since the 1980s in the US also contributed significantly to the formation of the housing and credit bubbles before the GFC. Consequently, following a sharp tightening of credit standards during the crisis, the US entered an economic recession. The credit index reached its turning point again in 2012, consistent with the boom in other forms of debt such as student loans and auto loans (Haughwout et al., 2019).

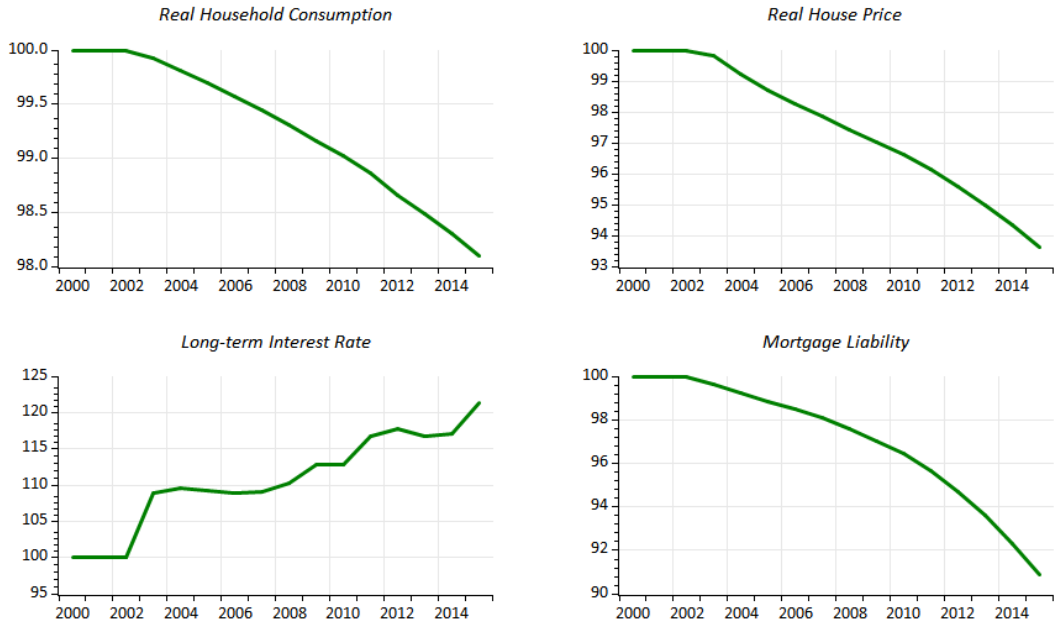
The final simulation concerns the role of US monetary policy in the financial crisis. As an exogenous policy variable, we assume the Federal Reserve raised the short-term interest rate by 100 bps through open market operation (OMO) from 2003 (see Fig. 3.17) so that it returned to the early 2000 level before the crisis. This is in line with Taylor's (2018) proposal - the Fed failed to follow Taylor rule and raised the policy rate too little, too late.

Figure 3.17.: Monetary policy shock, 100 basis points, 2003-2016

As the benchmark for all other interest rates in the market, an increase in short-term interest rates would lead to a rise in the long-term interest rate. As presented

in Fig. 3.18, the long-term interest rate would have been 40 bps higher than the baseline scenario. During the simulation period, the real house price and mortgage liabilities, compared with the baseline, decline by around 8 per cent and 12 per cent respectively. These together contributed to a 0.8 per cent deviation from the baseline level of real household consumption.

Figure 3.18.: Monetary policy shock, 100 basis points, 2003-2016



3.7. Conclusion

In the previous chapter, we conducted an extensive literature review on three influential hypotheses regarding the underlying causes of the GFC. These are the GSG, GFG and EM hypotheses. Like all scientific research, a hypothesis can only become a theory when there is sufficient accumulation of empirical evidence to support the key claims of the hypothesis. This essay has sought further evidence for the three hypotheses by investigating the most up-to-date US data, given the importance of the US economy in all three stories.

It has been over a decade since the onset of the GFC. As the theoretical debate continues, the empirical literature also presents mixed results on the validity of each hypothesis. This chapter contributes to this strand of the literature by investigating

four critical yet interconnected empirical questions after mapping out the logic links from all three hypotheses.

The first question relates to the role of credit access and house prices in determining US domestic consumption. Our ECM consumption model confirms that mortgage lending and housing wealth are indeed positively correlated with US household consumption, but the statistical significance of these relationships do not appear to be robust when time periods are used. However, the interaction effects between mortgage lending and housing wealth, captured by housing equity withdrawal, is highly significant and positively correlated to household consumption both in the pre-crisis and post-crisis periods.

The second question focuses on identifying the domestic determinants of the boom and bust cycles in the US housing and credit markets. For the housing market, the rent-arbitrage model appears to be consistent with the empirical findings. Various measures of credit conditions are used, but only short-term effects are identified. In terms of the mortgage liability model, the data suggests the real house price has a strong positive correlation with mortgage liabilities in both the long-run and the short-run. Credit condition measures have also played a role in the mortgage credit boom, but only in relation to long-run effects. The data confirm the reinforcing cycle between mortgage lending and house prices and the observed effects from credit measures do seem to support the EM hypothesis.

The third question is at the core of the GSG and GFG debate. It is about the relative importance of trans-Pacific capital flows and trans-Atlantic capital flows in causing the GFC. To answer this question, we investigated the data on foreign holdings of US long-term securities in the housing and mortgage liability models and found no direct linkages between foreign capital inflows and the US credit and housing boom before the crisis. Other major structural shifts in the macroeconomic environment after 2008 (e.g., unconventional monetary policy such as QE) appear to be important in explaining the movements of house prices during the post-crisis period. The statistical significance of the credit standard measures is robust even after controlling for international capital flows.

The fourth question is a direct extension of the third, as there might be an indirect channel for international capital flows to influence the US domestic economy through the long-term interest rate. Because the long-term interest rate is implicitly correlated with the real user cost, credit conditions and the repayment rate, it has

proved to be crucial in explaining the housing and credit boom. The housing and credit boom are in turn responsible for the consumption boom in the US before the GFC. From the data analysis, we find both the foreign purchase of Treasury bonds and corporate bonds indeed exert downward pressure on the long-term interest rate. While the former has long-term effects, only short-term effects are observed for the latter. Therefore evidence for both GSG and GFG hypotheses is identified.

Due to the two-way interactions among the four variables of interest, a partial equilibrium model - USMOD is built to take account of both direct and indirect effects from these variables. The results are very revealing. Although both trans-Pacific and trans-Atlantic capital flows played a role in lowering the US long-term interest rate, during the GFC it was the foreign purchase of the corporate bonds that fell and which had a negative impact on the US housing and credit markets and ultimately household consumption. The foreign holding of US Treasury bonds continued even after the GFC, which acted as a stabiliser for the economy. Should its trend have followed corporate bonds, the economic recession could have been worse.

The simulation results further suggest that both domestic credit standards and loose monetary policy were responsible for the GFC. In the next Chapter, a large scale empirical model for the UK, a country that was also severely hit by the GFC, will be constructed to further study the effects of domestic credit creation in the banking sector.

4. A Stock Flow Consistent (SFC) model for the financial crisis

4.1. Introduction

The GFC has acted as a wake-up call for many economists and has stimulated vigorous debate about how we should model the economy. The previous two chapters have discussed the theoretical and the empirical validity of the endogenous money theory in explaining the GFC. The banking sector is much more than just a submissive financial intermediary that simply channels resources efficiently from savers to borrowers, as it is often characterised in textbooks. Instead, it has a life-cycle of its own. Banks do not need to attract deposits from savers to lend. Money can be created in the economy through lending and destroyed through repayments from borrowers. For example, when a mortgage is issued to purchase a house, an equal amount of bank deposits will be credited to the borrower's bank account automatically, and the deposits are subsequently destroyed once the mortgage is repaid in full. The feedback cycle between house (asset) prices and mortgage lending is evident not only in theory but also in the empirical chapter. As shown by Minsky's FIH, the boom-bust cycle of asset prices and credit reinforce one another and this feature is inherently endogenous to the modern capitalist economy.

A failure of mainstream macroeconomic models to recognise the importance of this characteristic of the modern capitalist economy was one of the essential contributory factors of the GFC. Given this failure, certain key questions arise. In particular, will there be a paradigm shift in macroeconomics, similar to the ones after the Great Depression (GD) in the 1930s and the Great Inflation (GI) in the 1970s? Furthermore, should the discipline of macroeconomics embrace pluralism? In an attempt to make a contribution to these important debates, this essay firstly provides a brief review of mainstream macroeconomic models before the crisis and then looks

to the possible future of macroeconomic models.

The Stock-Flow Consistent model (SFCM) has attracted a considerable amount of interest from both academic researchers and policymakers since the onset of the financial crisis in 2008. SFCM is a type of accounting-based macroeconomic model that emphasises the integration of all the flows (e.g., GDP) and the stocks (e.g., wealth) within an economy. A typical SFCM has two major components: an accounting framework and a set of behavioural assumptions. The accounting framework describes all economic activities in three matrices: (1) a stock matrix records the physical and financial wealth of an economy at a given period, (2) a flow matrix depicts all the economic transactions within a period, and (3) a revaluation matrix details the net capital gains from assets. The integration of these three matrices can capture all the economic dynamics of any country at a given period. The behavioural assumptions, based on established economic theories, provide economic meanings among variables that are not explicitly revealed by accounting relationships.

Several features of the SFC approach make it suitable as a tool to analyse the financial crisis. Firstly, the comprehensive accounting framework ensures everything comes from somewhere and goes somewhere. Hence there are no black holes in the system. Bezemer (2011) saw the 2008 financial crisis as a natural experiment in testing the validity of economic models and found that accounting models offered more promising forecasting results than their mainstream counterparts. Secondly, the SFC modelling approach provides an integrated approach to analyse the real and financial sides of the economy. For example, credit creation, banking behaviours, saving and financing decisions and capital gains, which were mostly ignored by mainstream models, can all be included in the analytical framework. Hence, accounting-based models are well-equipped for issues, such as the financial crisis, which come about as a result of a large number of complex and interrelated factors arising from different sides of the economy. As described in the previous chapter, the accounting-based methods helped Godley (1999) and Godley and Zezza (2006) successfully predict both the financial crisis in the early 2000s and the GFC. While the debate about how to fix mainstream macroeconomic models is on-going, Godley and Lavoie (2012; 2007) have suggested one practical way forward.

This essay comprises three crucial building blocks. The first is the methodology section, which reviews the development of the SFCM approach and the methodological

debates on the future of macroeconomic models ignited by the financial crisis in 2008. The second focuses on Chapter 11 of Godley and Lavoie (2012) as a starting point to demonstrate how a single economy with a financial sector works in a theoretical SFC model. The third then focuses on an empirical SFCM and how it can be applied to a particular economy, in this case, the UK. As another economy severely affected by the GFC, a credit creation scenario is simulated in the UK to better understand the interactions between the financial sector and the economy at the macro-level before the crisis.

4.2. Literature review

4.2.1. The development of macroeconomic models: before and after the GFC

Over the past hundred years, the development of macroeconomics has experienced two paradigm shifts. Each was accompanied by, or was a direct consequence of, an extreme economic event, such as the GFC. The first was the Great Depression (GD), which led to the birth of Keynesian macroeconomics. Before the GD, the dominant approach of economic modelling was the partial equilibrium analysis following the Marshallian tradition. Even Keynes himself, a student of Marshall at Cambridge, was trained using this tradition. Under the Marshallian framework, unemployment only occurs when wages persist above the clearing level due to the presence of some factor (e.g., trade unions) that is externally imposed on the market operation. As a result, removing the obstacles that prevent wage reduction seems to be the apparent solution for unemployment. A similar partial equilibrium analysis can be applied to saving and investment with interest rates acting as the 'price' in the capital market. An interest rate that is higher than the market-clearing level will cause an excess of savings over investment. Under such an analytical framework, it is impossible to establish linkages among investment, output and the mass unemployment observed in developed countries during the GD.

The GD stimulated intellectual debates in the 1930s. Keynes (1936) focussed on seeking an explanation and a solution for one of the worst economic recessions in modern history. Keynes's General Theory of Employment, Interest, and Money (General Theory hereafter), as a response to the GD, was widely accepted by up-

and-coming economists across the Atlantic (Temin and Vines, 2014). The General Theory challenged the partial equilibrium analysis by providing an alternative analytical framework. Keynes was the first to link unemployment in the GD, under the principle of effective demand, to the failure in the production market. To do so, one must abandon the partial equilibrium approach. Some workers become jobless because of the shortage in job supply created by the Paradox of Thrift[1], not the oversupply of labour at higher than market-clearing wages. Such unemployment is now known as involuntary unemployment as opposed to voluntary unemployment. Following Keynes's analysis, policies to fix mass unemployment should focus on how to raise the equilibrium level of employment through demand management rather than removing obstacles that prevent employment returning to its equilibrium level (Skidelsky, 2010). The golden period of Keynesian economics, when it reached its height of influence, occured between the 1940s and 1960s.

For theoretical models, the IS-LM framework, advanced by Hicks (1937) and Hansen (1953), provided a simplified structure to convey the essential messages of Keynes in a closed economy setting. It has made Keynes's work more accessible to students (Temin and Vines, 2014). Based on this framework, Mundell (1963) and Fleming (1962) developed the Mundell-Fleming model[2], which became the workhorse model in the open economy. On the empirical side, macroeconometric models that are grounded in Keynesian economics, such as the Wharton Econometric Forecasting model[3] (see Evans and Klein (1967)), also gained popularity in both academia and policy institutions.

The Great Inflation (GI) of the 1970s followed by stagflation in many advanced economies was another turning point in the development of macroeconomics. It occurred against a backdrop of Keynesian economics coming under sustained criticism from Chicago School economists such as Lucas and Sargent (1979). They argued that econometric policy evaluation procedures failed to recognise that optimal decision rules of economic agents vary systematically with changes in policy. Therefore, the parameters in the model are dynamic, not static. Relationships in the past cannot be used to make inferences concerning the future. This is known as the Lucas critique.

[1] An attempt to increase saving at the micro-level could result in a fall in aggregate saving at the macro-level, due to the decline of aggregate household consumption and income.
[2] It is also known as the IS-LM-BP model.
[3] The Klein-Goldberger model developed by Goldberger and Klein (1955) for the US economy was the first generation of such a model.

Moreover, Sims (1980) focused on the identification methods used by the large-scale structural econometric models (SEM) and the severe endogeneity problems they suffer from, suggested Vector Autoregression (VAR) analysis as a way forward. As all aggregated models, both theoretical and empirical, inevitably suffer from the Lucas critique, it led to the decline of using large-scale structural econometric models (SEM) at the aggregate level in academia and to the rise of micro-founded macroeconomic models[4] such as the Dynamic Stochastic General Equilibrium (DSGE) models, which place greater emphasis on internal consistency. Wren-Lewis (2018) coined the term New Classical Counter-Revolution (NCCR) to describe the second paradigm shift in macroeconomics. According to Gali and Gertler (2007), the NCCR took place because the widely used macroeconomic models such as the Wharton model were unable to predict structural breaks such as the GI in the 1970s.

However, unlike the first paradigm shift after the GD, when Keynesianism provided a coherent explanation and solution for the problems revealed by the crisis, the NCCR did not offer a sound alternative explanation and solution for stagflation. The first-generation DSGE model - the Real Business Cycle (RBC) model placed considerable emphasis on internal consistencies, that is, all aggregated behaviours in the model are derived from inter-temporal optimising micro-behaviours based on the rational expectations hypothesis. It considered neither inflation nor monetary factors. The external consistency[5] of such models is thus considerably compromised (Christiano et al., 2018). In fact, the predictive ability of the traditional SEMs can be significantly improved by augmenting expectations into the Philips curve (Wren-Lewis, 2018). Despite the dominance of micro-founded models in academia, aggregated models remain widely used in professional and policy institutions (including central banks and international organisations such as the IMF), due to their better performance in terms of external consistency and forecasting.

The second-generation DSGE models, namely the New-Keynesian DSGE (NK-DSGE), were designed to improve the frictionless RBC models by incorporating more Keynesian elements, such as sticky wages, into their analysis. Arestis (2019) summarised the main features of such models using six equations. Given the assumption of rational expectations, the inter-temporal optimising behaviour of the representative agent and firm results in the aggregate demand function for the output gap and the

[4]Representative agents have rational expectations and optimise decisions based on intertemporal budget constraints. The influence from both schools diminished as funding was directed towards micro-founded macroeconomic models in the 1980s. (Wren-Lewis, 2018)

[5]That is the ability to match dynamics of real data.

Philips curve respectively. The current level of the output gap is jointly determined by the past and the expectation of future values of the output gap. The real interest rate and the real exchange rate can also influence it. The Philips curve describes the dynamics of the current price level. It is determined by the output gap, both its past and expected future levels, expected world prices and changes in the nominal exchange rate. The NK model normally introduces short-term rigidity through Calvo pricing[6].

It is then followed by a Taylor rule type equation for the monetary policy rate. It is derived from minimising the loss function of the Central Bank. The nominal monetary rate is determined by the real equilibrium interest rate[7]. The real exchange rate, the current account position, and the nominal exchange rate govern the dynamics of the external sector. The real exchange rate and current account are endogenous to each other. The other drivers for the real exchange rate are the conventional interest differentials between the domestic and the world economy and the expected value of the future real exchange rate, while the current account position is influenced by the domestic and world output gap. The nominal exchange rate is a log-linearised equation which contains the real exchange rate and differentials of price levels between the domestic and world economy.

There is no active role for the banking sector and money in the model. Instead, the banking sector is seen merely as a financial intermediary that efficiently allocates resources between savers and borrowers. The transversality condition[8] ensures that an inter-temporal optimising agent will always honour his/her debts in full by imposing a non-negative condition for wealth or the present discounted value of wealth at infinity. Therefore, the agent is not subject to any liquidity constraints. Unlike the monetary policy rate, which can influence real activities through market expectations of the future policy rate and the yield curve, the movements of money supply are only responsive to money demand at the desired interest rate. The supply of money thus only serves as a unit of account (Gali and Gertler, 2007).

After the GFC, the DSGE models without an active banking sector came under se-

[6]Calvo pricing relies on monopolistic competitive firms at the micro-level. These firms only re-optimise their prices after a fixed period of time.

[7]See Section 2.4.3 for a detailed discussion.

[8]According to Kamihigashi (2008), the transversality condition is a necessary condition to single out the optimal path in a optimal control problem by providing a constraint to the end point. It is also known as the non-Ponzi-game condition. Apart from the ever increasing debt level, it is also used to rule out optimal paths, such as an asset bubble.

rious criticism like the SEM did in the 1970s. Vines and Wills (2018) thus initiated a project of rebuilding macroeconomics at Oxford which sparked further discussions on the future of macroeconomic models. Wren-Lewis (2016; 2018) argued that the NCCR went too far in pursuing theoretical purity at the cost of external consistency. Given this, SEM, as a hybrid approach between DSGE and VAR, could be seen to offer a reasonable compromise for policy analysis. Pilkington (2013) demonstrated that the widely used representative agent macroeconomic models inevitably suffer from the fallacy of composition[9]. In Wren-Lewis's view, the GFC will not result in another paradigm shift such as occurred with the GD and GI, as the DSGE models are flexible enough to develop along with other changes such as incorporating the financial sector and heterogeneous agents. Wieland et al. (2016) offered a comprehensive review of the development of macro-financial models after the GFC. According to the review, Diamond and Dybvig (1983)[10] and Bernanke et al. (1999)[11] became the basis for mainstream macroeconomists to incorporate financial frictions into the model, but this line of research remains in its infancy. Hendry and Muellbauer (2018) further pointed out that the reliance on Euler equations heavily constrains the dynamics of consumption behaviour in the DSGE models. Other common assumptions in these models, such as representative agents, perfect information, zero transactions costs and efficient markets, leave no essential roles for money, asset prices and credit cycles.

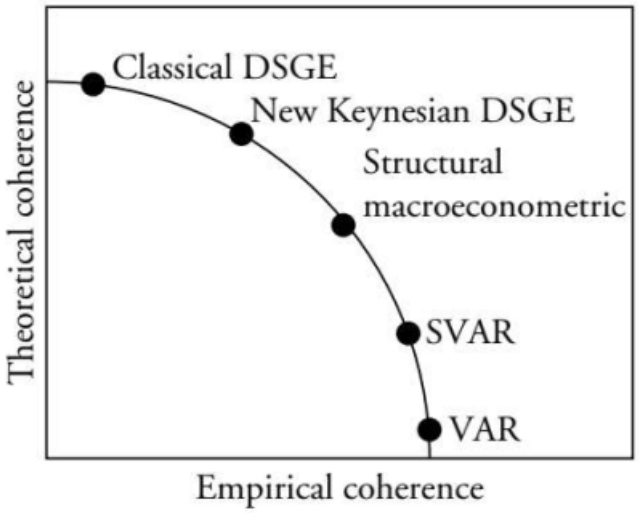
Blanchard (2018), however, suggests a greater tolerance for pluralism in macroeconomic modelling. He advocates a suite of five kinds of models for different purposes (see Fig. 4.1). For example, he asserts overlapping generation (OLG) models can serve as a foundational model that satisfies theoretical purity; DSGE models are useful for understanding macroeconomic implications as a response to market distortions; and SEM, which Blanchard refers to as the policy model, is suited to simulating the dynamic effects under different policy scenarios.

[9] It says that the behavioural relationships that held true at the micro-level might not necessarily hold true at the macro-level.

[10] Using game theory, the model offers two equilibria in the banking sector: a good equilibrium during normal times and a bank run equilibrium during crisis.

[11] They emphasised the financial accelerator effects generated by the presence of costly state verification in dealing with the contracts with borrower - enterprises.

Figure 4.1.: Theoretical and empirical coherence frontier for mainstream macroeconomic models



Source: Passarella (2019)

There are two extreme cases: toy models and forecasting models. The IS-LM model is one example of a toy model. These models could serve as a pedagogical device to answer specific theoretical questions. The forecasting models, on the other hand, are solely responsible for producing the best possible economic forecasts regardless of whether there is a theoretical foundation or not. A useful lesson of the GFC is that economists and policymakers should not expect a model to produce reliable answers for questions that are beyond the purposes they were originally designed for.

4.2.2. The development of SFC models

While mainstream macroeconomic modellers have shifted their focus to adding financial frictions, heterogeneous agents and other more realistic assumptions into the DSGE models after the GFC, the SFC modelling approach has also drawn increasing attention in recent years. This section provides a brief account of the development of the SFC modelling approach à la Godley and Lavoie (2007) to demonstrate why it is the preferred method for analysis of financial crises. Caverzasi and Godin (2013) and

Nikiforos and Zezza (2017) offer comprehensive surveys on the recent development of SFCMs.

The roots of SFC models can be traced back to the work of Morris Copeland, the father of the flow of funds, in 1949. At that time, Copeland (1949) intended to study the interaction between the money flows (sources/uses of funds) and fluctuations in aggregate expenditures on national product. His analysis was the first attempt to bring both the real and financial sides of the economy together under a single analytical framework. It then took the efforts of two leading scholars, James Tobin (the Yale school) and Wynne Godley and his co-authors (the New Cambridge School), to develop it into its current form. Tobin (1982) in his Nobel Prize lecture listed five features that differentiate his work from the standard IS-LM Keynesian framework:

1. Precision regarding time
2. Tracking of stocks
3. Several assets and rates of return
4. Modelling of financial and monetary policy operations
5. Walras's law and adding up constraint

All five features are compatible with the modern SFC models presented in Godley and Lavoie (2007). Features (1) and (2) echo the very core of the SFC approach. As for every specific point of time, there is a set of stock values in the economy that are listed in a sectoral matrix, known as the stock matrix. With the help of the transaction flow matrix (changes in payments/receipts and net acquisition of new assets/liabilities) and the revaluation matrix (changes in values), a new stock matrix at the end of the period is generated[12]. In a standard IS/LM model, the bill rate is the only rate of return and money is the single financial asset within an economy. Feature (3) emphasises the importance of modelling a sophisticated financial system in the modern economy. Tobinesque portfolio allocation, based on the different rates of return, has become one of the most widely used behavioural equations in theoretical SFC models. Feature (4) was mainly missing from the mainstream models (e.g. DSGE) before the financial crisis, as the financial sector was treated in such models as an intermediary with little role in money creation. The endogenous money creation view[13] is fully integrated into the SFC models. A simple money

[12]See Section 4.3 for more detail.
[13]See Section 2.4 for a detailed explanation.

circuit can be described as follows. Money is firstly created by the banking sector to finance production and subsequently destroyed after full repayment together with interest. Feature (5) is consistent with the accounting consistency requirements advocated by SFC modellers[14]. For example, the horizontal consistency in the stock matrix implies that the financial assets held by one sector must be matched by the same amount of financial liabilities of another sector.

Although both the Yale School and the New Cambridge School agree on the above modelling features, the two schools still hold different views concerning the behavioural assumptions behind the accounting identities. The former embraces neoclassical assumptions (e.g. general equilibrium) like the New Keynesian school, while the latter mainly follow the premises found in Post-Keynesian economic theories[15]. This section does not intend to provide an exhaustive review of the differences between the two schools but instead only highlights a few key differences.

Apart from Tobin, Taylor (2008) pointed out that Godley's SFC approach is closely related to other Cambridge economists. Its accounting framework is an extension of the Social Account Matrix (SAM) developed by Richard Stone, and the causal assumptions can be traced back to Keynes and Kaldor. Nikiforos and Zezza (2017) presented a way to reconcile the SFC transaction flow matrix with the SAM. After some modification of the SAM, the two matrices essentially cover the same information. In fact, according to Shipman (2019), Stone's Grow Project was running in parallel when Godley was the director of Cambridge Economic Policy Group (CEPG) until the early 1980s. The advantage of the SAM is that it is readily compatible with the Input-Output (IO) tables[16] and the national accounts conventions adopted by most countries across the world. This means data are much easier to collect. Recently there have been some attempts to bridge the IO analysis with the SFC framework, especially for ecological models that have a focus on energy analysis (e.g. Berg et al. (2015)).

[14]Zezza and Zezza (2019) listed five consistency conditions that are required by all SFC models.

[15]See Lavoie (2014) for a discussion on the major differences between mainstream and Post-Keynesian theories.

[16]Most of the IO Tables published today are known as the Supply and Use Tables (SUTs), which are derived from the work of two Nobel Prize laureates in economics: Wassily Leontief and Sir Richard Stone. SUTs reveal a detailed structure of the inter-industry linkages that exist within a region. It is the starting point for a complete social accounting matrix (SAM). In order to use the IO table for analytical uses, it needs to be transformed into analytical tables.

Table 4.1.: The advantages and disadvantages of SFCM

Pros	Cons
Typically use national accounting constraints to provide a framework	The model equations are not explicitly linked to the optimisation problems of particular agents
Allow modelling of gross flow and balance sheet positions by sector	The framework is not yet well-established, which makes it harder to take on board insights from other work
Can be used to model feedback from financial asset and liability positions to the paths for production and spending	The complicated system makes it hard to explain the primary economic mechanisms at work
Can include an important role for money, credits, and financial system	The data requirements are large relative to standard DSGE models
Can offer a framework for exploring different specifications for agents expectations	Model parameters suffer from the Lucas critique: they can be affected by changes in policy regime or time series properties of the driving processes
Arguably SFC models have more realistic behavioural assumptions than many micro-founded models	The models are not explicitly linked to economic theories

Source: Burgess et al. (2016)

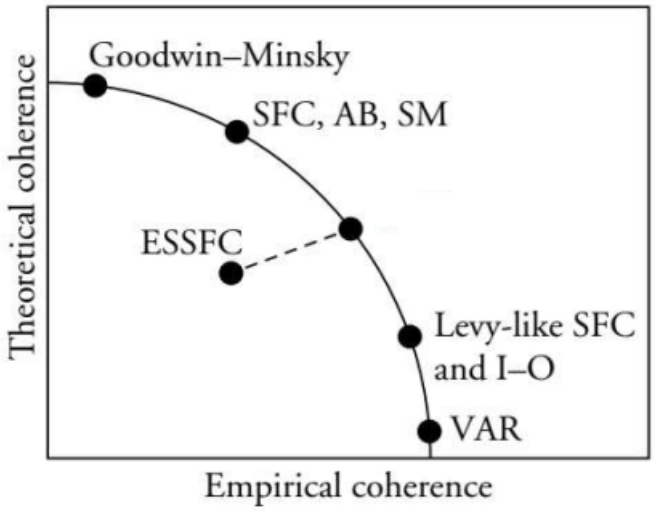
Burgess et al. (2016) listed the pros and cons of using SFCMs compared to standard DSGE models[17] (see Tab. 4.1). Of these, the ability to model gross capital flows (instead of net flows) and national balance sheet positions under different assumptions are essential in understanding the GFC. Although the analysis of international gross capital flows is not yet well-established, the SFC approach provides a solid analytical framework to go forward. Also, unlike their mainstream counterparts[18], SFCMs allow for an important and realistic role for money, credit and banks, which are fully integrated with the real side of the economy. Besides, SFC models, despite not being micro-founded and suffering from Lucas critique, can nonetheless impose more realistic specifications for expectations and are more realistic than typical DSGE

[17]The BoE's COMPASS model is chosen as a representative for the standard DSGE model.
[18]Financial sector is mainly added as frictions into the economic systems.

models in terms of the behaviour, and heterogeneity of agents.

Hence we believe that the SFC approach should be taken more seriously in macroeconomics or at least should become one of the models in the suite of analytical tools for macroeconomic analysis proposed by Blanchard (2018). As Fig. 4.2 reveals, in terms of their theoretical-empirical coherence, the SFC models can lie on both ends of the frontier for different research purposes. Both theoretical and empirical SFC models will be discussed in the methodology section. While the former is useful for examining theoretical hypotheses and arguments, the latter works better for medium to long-term forecasting.

Figure 4.2.: Theoretical and empirical coherence frontier for heterodox macroeconomic models



Source: Passarella (2019)

Given the complexity of the economic system in reality, all models suffer from the Lucas critique at some level. After all, the SFC accounting system and the microfoundations are not mutually exclusive. A group of SFC modellers, such as Caverzasi and Godin (2015), suggest combining the SFC framework with agent-based modelling (ABM) at the micro-level to counter the Lucas critique. However, like almost all economic models, the ABM-SFC approach also has to face the trade-off between realism and feasibility. This thesis does not intend to adopt the agent-based approach because doing so would add another layer of complexity to the already

complex financial transactions within the economy and would not necessarily provide more revealing results than the SFCMs modelled at the aggregate level. Also, given this approach is still in its infancy, it seems unlikely to be readily applicable to empirical modelling at this stage.

4.3. Methodology

The SFC framework is best described by Godley and Lavoie (2012). Within their book, Chapter 11 presents a growth model (GL11) for a single closed economy. It has a fairly developed financial sector, but it is still insufficient for our modelling purposes. This section firstly summarises both the accounting framework and behavioural assumptions of this model and then discusses recent developments in building empirical SFC models. The SFC model described in this section is a simplified, theoretical framework of an economy. Hence it does not reflect all the essential empirical features that have been discussed in previous chapters. For instance, the housing stock is still missing. It is intended as a prototype to demonstrate the usefulness of SFC approach in analysing financial flows within an economy and why the empirical SFC modelling approach is our preferred methodology for this study on the GFC.

4.3.1. SFC matrices

Like all SFC models, the economy is first described using a set of accounting matrices – the stock matrix, the flow matrix, and the revaluation matrix. These matrices provide a watertight accounting framework that sets boundary conditions for all economic relationships within the closed economy. There are five sectors: households, firms, the government, the central bank, and banks.

The stock matrix records all assets (with "+" sign) and liabilities (with "−" sign) within the economy. Each row within the stock matrix shows the interconnected asset/liability relationships across different sectors. Assets of one sector are liabilities of another, apart from inventories and fixed capital. Hence most rows add up to zero. For example, loans taken from banks are liabilities to households ($-L_h$) and firms ($-L_f$), but at the same time they are assets to the banks ($+L$). Within each sector (column), the difference between assets and liabilities gives the net worth of the

sector, which is regarded as a balancing item at the bottom row to ensure the sum of each column is also zero. For instance, households diversify their asset holdings among different assets: cash money from the central bank ($+H_h$) and other banks ($+M$), Treasury bills ($+B_h$), government bonds ($+BLP_{bl}$), and equities ($+eP_e$). Bank capital ($+OF_b$) are the funds of privately owned banks, which belong to the private owners of the banks, and therefore are categorised as household wealth. Households are assumed to only be liable to banks through bank loans.

The net worth of households (V_h) is thus equal to the sum of all assets and liabilities. The same principle applies to all the other sectors. The net worth of all five sectors must be, by accounting identity, equal to the stock of inventories and fixed capital within the economy.

Table 4.2.: Stock Matrix

	Households	**Firms**	**Govt.**	**Central bank**	**Banks**	**Σ**
Inventories		$+IN$				$+IN$
Fixed capital		$+K$				$+K$
HPM	$+H_{\mathrm{h}}$			$-H$	$+H_{\mathrm{b}}$	0
Money	$+M$				$-M$	0
Bills	$+B_{\mathrm{h}}$		$-B$	$+B_{\mathrm{cb}}$	$+B_{\mathrm{b}}$	0
Bonds	$+BL \cdot p_{\mathrm{bL}}$		$-BL \cdot p_{\mathrm{BL}}$			0
Loans	$-L_{\mathrm{h}}$	$-L_{\mathrm{f}}$			$+L$	0
Equities	$+e \cdot p_{\mathrm{e}}$	$-e \cdot p_{\mathrm{e}}$				0
Bank capital	$+OF_{\mathrm{b}}$				$-OF_{\mathrm{b}}$	0
Balance	$-V_{\mathrm{h}}$	$-V_{\mathrm{f}}$	$-V_{\mathrm{g}}$	0	0	$-(IN+K)$
Σ	0	0	0	0	0	0

Source: Godley and Lavoie (2012)

The flow matrix captures the net transactions across all sectors in the economy within a particular period. Different to the stock matrix, a capital account column is created to record the capital transactions of firms, the central bank and banks. The flow matrix consists of three major blocks.

The first block coincides with GDP accounting using the income and expenditure methods. Resource inflows are given "+" signs, while resource outflows are assigned "−" signs. The composition of GDP is best illustrated using the current account

column under the firm sector. Consumption expenditures from households ($-C$), government expenditures ($-G$), firms investment expenditures ($-I$) and changes in inventories ($-\Delta IN$) are all recorded as resource inflows under the current account. Combining all inflows, we have the GDP of the current period. In the same way as the familiar circular flow model, such resource inflows are again used to pay wages to employees ($-WB$), profits to entrepreneurs ($-F_f$) and for inventory finance ($-r^l_{-1}IN_{-1}$).

The second block describes interest payments across sectors. Banks earn interest from lending to households ($-r^l_{-1}L_{h-1}$) and from their holdings of government bonds ($-r_{b-1}B_{-1}$). At the same time, banks must also honour interest payments to depositors. The double entry system ensures that each row adds up to zero.

The third block is formally known as the flow of funds matrix. It outlines how savings/dissavings within each sector are distributed/financed. The government sector is used as an example. Government expenditures ($-G$) and its interest payments on bills ($-r_{b-1}B_{-1}$) and bonds ($-BL_{-1}$) are partially financed by tax revenues ($+T$) and the internal transfers from the central bank ($+F_{cb}$). The rest of the deficits are funded through the new issuance of Treasury bills ($+\Delta B$) and government bonds ($+\Delta BLP_{\text{bl}}$).

The revaluation matrix complements the flow matrix by adding capital gains into the picture. For firms, price movements will impact two of the major assets – equities and fixed capital. Unlike the other assets, fixed capital has no liability counterparts. Therefore, the capital gains from fixed capital will add to the accumulation of national wealth.

Combining the initial stock matrix with the results from both the flow matrix and the revaluation matrix, a new stock matrix will be generated, which sets the foundation for a dynamic economic system. Having constructed the accounting framework, behavioural assumptions must be assigned to establish the baseline model. The model will be solved either numerically or theoretically. The following subsections briefly describe the critical behavioural assumptions for each sector.

4.3.2. Households

The nominal incomes of households (YP) come from all income inflows (e.g., wages, dividends and interest earnings etc.) in the flow matrix. Households are liable to pay

Table 4.3.: Transaction flow Matrix

			Firms			Central bank		Banks		
		Households	Current	Capital	Govt.	Current	Capital	Current	Capital	Σ
Consumption		$-C$	$+\boldsymbol{C}$							0
Government expenditures			$+\boldsymbol{G}$		$-G$					0
Fixed investment			$+\boldsymbol{I}$	$-I$						0
Inventory accumulation			$+\Delta\boldsymbol{IN}$	$-\Delta IN$						0
Income tax		$-T$			$+T$					0
Wages		$+WB$	$-\boldsymbol{WB}$							0
Inventory financing cost			$-\boldsymbol{r}_{l-1} \cdot \boldsymbol{IN}_{-1}$					$+r_{l-1} \cdot IN_{-1}$		0
Entrepreneurial Profits		$+FD_f$	$-\boldsymbol{F}_f$	$+FU_f$				$+r_{l-1} \cdot (L_{f-1} - IN_{-1}) - r_{l-1} \cdot NPL$		0
Bank profits		$+FD_b$						$-F_b$	$+FU_b$	0
Central bank profits					$+F_{cb}$	$-F_{cb}$				0
Interest on	personal loans	$-r_{l-1} \cdot L_{h-1}$						$+r_{l-1} \cdot L_{h-1}$		0
	deposits	$+r_{m-1} \cdot M_{-1}$						$-r_{m-1} \cdot M_{-1}$		0
	bills	$+r_{b-1} \cdot B_{h-1}$			$-r_{b-1} \cdot B_{-1}$	$+r_{b-1} \cdot B_{cb-1}$		$+r_{b-1} \cdot B_{b-1}$		0
	bonds	$+BL_{-1}$			$-BL_{-1}$					0
Change in	loans	$+\Delta L$		$+\Delta L$					$-\Delta L$	0
the stocks of	cash	$-\Delta H_h$					$+\Delta H$		$-\Delta H_b$	0
	money deposits	$-\Delta M$							$+\Delta M$	0
	bills	$-\Delta B_h$			$+\Delta B$		$-\Delta B_{cb}$		$-\Delta B_b$	0
	bonds	$-\Delta BL \cdot p_{bL}$			$+\Delta BL \cdot p_{bL}$					0
	equities	$-\Delta e \cdot p_e$		$+\Delta e \cdot p_e$						0
Loan defaults				$+NPL$					$-NPL$	0
Σ	0	0	0	0	0	0	0	0	0	0

Source: Godley and Lavoie (2012)

income tax ($T = \theta YP$) and interest on their borrowing from banks ($r^l_{-1}L_{hd-1}$). The net outcome of the two gives the disposable income ($YD_r = YP - T - r^l_{-1}L_{hd-1}$).

The level of real household consumption (c) depends on the expected real regular disposable income (yd^e_r), real net lending (nl) and the net worth from the previous period (v_{-1}). $yd_{r-1}$is assumed to be dependent on the real regular disposable income of the current period (yd_r) and of the previous period, which grew by the productivity growth trend rate ($yd_{r-1} \cdot (1 + gr_{pr})$). yd_r not only reflects the real disposable income (YD_r/p), but also takes the capital losses, due to inflation, into account.

The gross amount of new loans to households is assumed to be proportional to nominal incomes. The proportion (η) is negatively related to the real lending rate and a borrowing limit (η_0) is assigned to reflect banking policy. Principal repayments are a fraction (δ_{rep}) of the previous level of the outstanding stock of loans (L_{hd-1}). The financial burden of households is given by the debt (including both principal and interest payments) to income ratio. Netting out the principal repayments from the gross amount of loans to households gives the net amount of new household

Table 4.4.: Revaluation Matrix

	Households	Firms	Government	Central bank	Banks	Σ
Bonds	$+\Delta p_{\mathrm{bL}} \cdot BL_{-1}$		$-\Delta p_{\mathrm{bL}} \cdot BL_{-1}$			0
Equities of firms	$+\Delta p_{\mathrm{e}} \cdot e_{-1}$	$-\Delta p_{\mathrm{e}} \cdot e_{-1}$				0
Bank equity	$+\Delta OF_{\mathrm{b}}$				$-\Delta OF_{\mathrm{b}}$	0
Fixed capital		$+\Delta p \cdot k_{-1}$				$+\Delta p \cdot k_{-1}$

Source: Godley and Lavoie (2012)

loans.

Households accumulate wealth using four main financial assets - money deposits (M_d), Treasury bills (B_{hd}), government bonds ($p_{bl}BL_d$), and equities ($p_e e_d$). The sum of these four assets in the stock matrix gives the current market value of the financial assets (V_{fma}) held by households. The money deposit is treated as residual in the model to bridge the gaps between expected incomes and realised incomes, given the demand for all the other assets are always realised.

$$\begin{bmatrix} M_d \\ B_{hd} \\ p_{bl}BL_d \\ p_e e_d \end{bmatrix} = \begin{bmatrix} \lambda_{10} \\ \lambda_{20} \\ \lambda_{30} \\ \lambda_{40} \end{bmatrix} V_{fma-1} + \begin{bmatrix} \lambda_{11} & \lambda_{12} & \lambda_{13} & \lambda_{14} \\ \lambda_{21} & \lambda_{22} & \lambda_{23} & \lambda_{24} \\ \lambda_{31} & \lambda_{32} & \lambda_{33} & \lambda_{34} \\ \lambda_{41} & \lambda_{42} & \lambda_{43} & \lambda_{44} \end{bmatrix} \begin{bmatrix} r_m \\ r_b \\ r_{bl} \\ r_K \end{bmatrix} V_{fma-1} + \begin{bmatrix} \lambda_{15} \\ \lambda_{25} \\ \lambda_{35} \\ \lambda_{45} \end{bmatrix} YP \tag{4.1}$$

The above matrix demonstrates how the wealth of households is invested in these four financial assets under a Tobinesque allocation system[19]. The assumption on the expected investible wealth is simplified to the previous level of financial assets. The relative holding of financial assets is affected by the corresponding returns for each asset and current period income flows.

[19]The coefficient matrix has to satisfy both vertical and horizontal adding up conditions. See Lavoie (2014) for a detailed discussion of this issue. The portfolio allocation behavioural equations are greatly simplified in the UKSIMM.

4.3.3. Firms

Firms' real output decisions differ from the typical macroeconomic models by introducing the concept of inventories into the equation. Therefore, the choice of real output depends on firms' expectations of real sales (s^e) and changes in inventories (in^e). The expectation functions are given below,

$$s^e = \beta s + (1-\beta)s_{-1}(1+gr_{pr}); \qquad in^e = in_{-1} + \gamma(in^T - in_{-1})$$

The expected real output level is assumed to be a weighted average of current and previous sales. Productivity growth is added to the latter to reflect the long-term growth rate. The expected level of inventory coverage towards the long-run inventory target level (in^T) at a speed γ. in^T is assumed to be proportional to s^e. The inventories are valued at their cost of production.

The capital formation grows at a rate, gr_k, which is positively correlated to the rate of utilisation of capacity (u) and negatively related to the real lending rate (rr_l). u is proxied by the real output produced from one unit of capital (y/k_{-1}). Real investment is a flow concept. It gives the change in capital stock levels, which takes both growth and depreciation into account.

For simplicity, the model assumes a single price for sales, investment, and capital stocks. The price adds a mark-up to the unit costs. The mark-up is considered to be regularly adjusted to meet the ideal mark-up, which is given by the targeted profits per unit of expected historical costs (F^T/HC^e). F^T must be sufficient to cover dividends, interest payments, and the target retained earnings. HC^e is the weighted average of expected sales measured by the actual unit costs at both the current and previous period.

The target real wage rate responds to labour productivity, and the bargaining pressure exerted from the demand side. The relationship, also known as the Philips curve, can be further adjusted to match empirical observations. In the model, a flat segment is introduced to reflect evidence from UK data that prior to 1975 the inflation rate did not respond to changes in employment levels within a specific range.

The last set of behavioural equations focus on the capital accounts of the firm sector.

Under the third column of the flow matrix, the accounting identity gives the demand for loans,

$$\Delta L_{fd} = I + \Delta IN - FU_f - \Delta e_s p_e - NPL$$

Investment, by assumption, is entirely financed by retained earnings and equities. Hence the demand for loans is wholly driven by the variation in inventories. Defaulted loans (NPL) are treated as financial transfers to firms from the banking sector. It assumes that a fixed share of loans will end up as non-performing loans.

4.3.4. Government and central bank

Government behaviour is relatively simple. It collects tax revenues from households. The growth rate of public expenditures and the income tax ratio can be exogenously set by the government based on its fiscal policies. The government is liable to pay interest on its previous period debt stock. Therefore, the government deficit is given by the difference between public expenditures (including interest payments) and tax revenues. The gap is financed through the issuance of Treasury bills and bonds.

The Central Bank (CB) is a semi-independent public entity, in the model, that is separate from the central government. The money supply from the CB is driven by demand from other sectors (e.g. households and firms). Also, the Bank's asset position (Treasury bills) must always match its liability position (money supply) on the balance sheet. Therefore, the stock of the Treasury bills under the Central Bank must be equal to its money supplies at all time. The Bank's profits are the interest earnings from the Bank's holding of Treasury bills. Given its status as a public entity, such profits are transferred back to the government sector as a stream of revenue. The interest rates of the Treasury bills and bonds are exogenously determined. The long-term interest rate adds a mark-up to the interest rate on bills, while the short-term rate is a policy variable.

4.3.5. Banks

This focus on consumption/production financing, debt, and portfolio behaviours requires a detailed examination of the financial system. Banks and their balance

sheets have to be fully integrated into the production process, and interest flows have to be explicitly taken into account. The SFC framework offers a comprehensive approach to fully integrate the financial system into the real economy, which is essential to understanding the mechanism of the credit cycle.

In this model, the supply of money deposits and loans are mainly demand-driven. In other words, banks will always meet the demand of credit-worthy borrowers from different sectors within the economy to ensure the market is in equilibrium. A percentage of banks' money deposits must be held as high-powered money at the central bank to meet the reserve requirement set externally by regulators.

Liquidity is measured by the ratio between banks' holdings of bills and money deposits. Although banks have no direct control over the holding of bills, they can indirectly influence the holdings through the spread between the deposit interest rate and the interest rate of the bills. A higher interest rate for deposits relative to the bill rate will reduce the holdings of bills.

The lending rate is assumed to add a mark-up over the deposit rate. The mark-up is set to meet banks' target level of profits (own funds) aiming to absorb the fluctuations in default loans and to achieve the capital adequacy ratios set by domestic/international regulators. In other words, banks must hold a minimum amount of their own funds as a proportion of their assets that are associated with risks. In this model, the capital adequacy ratio is given by the banks' own funds as a percentage of corporate and personal loans. Because other assets (e.g. the bills and cash) are assumed to carry little or almost zero risk.

4.3.6. Empirical SFC models

Applying the SFC approach to the empirical data of a particular country was the initial intention of Wynne Godley in the 1970s (Zezza, 2019). Godley often referred to Coutts et al. (1985) as the first comprehensive attempt at constructing a consistent accounting framework. This work also saw a stock matrix presented for the first time. However, the complete theoretical framework, as described in previous subsections, only became available following the publication of Godley and Lavoie (2007). Section 3.1 has briefly illustrated how the sectoral financial balances approach, an early version of the empirical SFC analysis, was useful in shaping Godley's analysis and prediction concerning the sustainability of the US economy. After the GFC, a

growing interest in developing an empirical SFC has developed not only in academia but also in policy institutions such as the BoE (See Burgess et al. (2016)). Zezza and Zezza (2019) and Nikiforos and Zezza (2017) provide a comprehensive list of countries that have already developed empirical SFC models at various scales.

Despite the rapid development, this strand of the SFC literature remains relatively under-researched. Much of the SFC literature focuses on building GL11 type simulation models to examine theoretical arguments and explore medium-term dynamics under different scenarios. Although there are no 'black holes' in the accounting structures, explicit explanation concerning how the initial values are determined in these models are mostly absent. These values are of great importance in generating the desired model simulations. For example, the GL11 model consists of more than 100 variables, but the initial values are highly hypothetical and unitless with minimal explanation given concerning how they are derived[20]. As a first attempt, as part of this thesis, a semi-empirical SFC model was constructed to introduce some realism into the baseline model.

The accounting structure of GL11 has been kept, but the behavioural equations have been significantly simplified[21] to stabilise the simulation. All initial values have been replaced by UK national accounts 2013 data, measured in billions, which is the reference year used by the national accounts, so that it gives the price level of 1 initially. The setting of a closed economy, along with many other simplifications in the accounting matrices, imposes restrictions on the degree of freedom and some data must be estimated and reconciled using mixed methods. After a lengthy process of trial and error, the model can indeed be stabilised after 15 years (annual model). Hence simulated results from the sixteenth year are chosen as the starting year in order to remove the initial fluctuations using UK data. However, after 15 years of simulation, the initial values again deviate considerably from reality. The purpose of bringing realism into the model is thus lost using this method[22].

The unsatisfactory results from the semi-SFC models led us instead to develop a fully estimated empirical model from scratch, similar to the initial intention of Wynne

[20]We thank Professor Gennaro Zezza, who kindly provided guidance on this issue while I visited the Levy Institute in the summer of 2018. From our informal conversations, I learned that these initial values were generated through a long process of trial and error through the model simulations.

[21]For example, the Tobineseque portfolio allocation is replaced by fixed share allocations.

[22]This issue deserves more attention. Having been through a minor detour during this PhD research journey I hope my experience can guide future SFC researchers to travel a smoother path.

Godley. In fact, according to Godley and Lavoie (2007),

> "Our accounting will always be solid and comprehensive – and this by itself will carry us a considerable distance, particularly when it comes to characterising the interactions between the real and financial parts of the more elaborate models. But we leave every functional relationship in a primitive state yelling to be more thoroughly explored."

At the same time, the presence of new research papers that pursue similar lines of inquiry, such as Zezza and Zezza (2019) and Passarella (2019), have provided additional assurance for the change in the direction of the methodology.

The aim of building a realistic empirical SFC model is to better understand and investigate the interactions between the financial sector, especially the credit cycle, and the overall economy in a more realistic setting. There are three key reasons that the UK has been chosen as the focal country of analysis. Firstly, as one of the principal global financial centres and one of the economies most severely affected by the financial crisis, the financial system of the UK shares a lot of similarities to its US counterpart. Furthermore, as noted previously, both countries experienced rapid financial liberalisation during the Thatcher and Reagan administrations in the 1980s.

Secondly, the UK is one of the most active financial trading partners with the US, as shown in Fig. 3.11. According to Avdjiev et al. (2016), the gross capital (round trip) flows between the UK and US before the GFC far exceeded the capital inflows from emerging economies such as China. Consequently, it was European banks, not Chinese banks, that bore the majority of losses from the subprime mortgage crisis. Therefore, modelling the UK economy, should generate valuable evidence from another country's perspective to supplement empirical analysis of the US.

Finally, the availability of UK data is another major advantage. A fully estimated SFC model requires abundant time-series data to ensure accounting consistency and the estimation of robust behavioural parameters. Mortgage market data in the UK is both better recorded and more accessible than that in the US.

To the best of our knowledge, to date there have only been three empirical SFC models developed for the UK. Davis (1987a) was the first attempt, as part of the BoE's initiative to improve its macroeconomic modelling. The model simulation results highlighted the importance of financial assets in explaining the dynamics of critical macroeconomic variables, such as consumption and employment, in the

UK. However, Davis (1987b) also acknowledged the limitations of his model, which deserves further development. One limitation highlighted is the absence of bank credit and its impact on expenditures. To remedy this, bank sector behaviour has to be modelled, but detailed UK balance sheet data across sectors only became available from 1987. Unfortunately, there was no follow-up to this line of research in the 1990s when the data was available. A more recent attempt has come from the Centre for Business Research's (CBR) UKMOD developed by Gudgin et al. (2015), The UKMOD is grounded in the UK national accounts with a particular focus on forecasting accuracy. More considerable attention has been given to the external consistency of the model with 80 behavioural equations that are econometrically estimated. Like the model presented by Davis (1987b), although the UKMOD follows SFC accounting, it also does not have a banking sector, so its ability to identify future financial crises is significantly compromised. Burgess et al. (2016) resumed the BoE's interest in SFC modelling for the UK economy in the 1980s and the empirical model they developed is by far the most complex in the empirical literature. Both calibration and econometric methods were used to estimate the coefficients in the model. Most importantly, the banking sector is finally presented after three decades of pursuit. In terms of scale, it is much smaller in comparison with the UKMOD to meet the behavioural assumptions specified for the transactions flow matrix.

The UK Simulation Model (UKSIMM) extends the UKMOD by adding detailed sectoral financial balance sheets and a more comprehensive financial system. It essentially models the entire UK 2018 national accounts[23], also known as the Blue Book (BB). Therefore the majority of data in our model are from the UK Office for National Statistics (ONS). Compared with the BoE model, the UKSIMM is modelled at a much larger scale and fully estimated using time series econometrics. It thus allows more realism to be incorporated into the model. To the best of our knowledge, it is the first and only large-scale empirical SFC model for the UK economy at the time of writing.

The UKSIMM is designed[24] to study the impact of the housing credit boom, which was the critical empirical feature observed in the financial market before the GFC,

[23]The glossary definitions are consistent with the OECD definitions as described by Lequiller and Blades (2007).

[24]Obviously, the model can be tailored to meet demand for other relevant research questions. For example, the role of shadow banking requires the addition of non-bank financial institutions to be modelled along with the banking sector.

in the UK. A credit cycle and its impact are presented in the simulation section. Differing to the partial equilibrium model for the US economy, the UKSIMM is a general equilibrium model, so it provides a more complete account of the transmission mechanisms between the financial sector and the overall economy. The UKSIMM expands to full national accounts and is econometrically estimated. The following section describes the fully estimated empirical SFCM for the UK economy. Our work thus builds on the previous literature and offers the first UK empirical SFC model at this scale.

4.4. An Empirical UK Simulation Model - UKSIMM

There are five sectors in the model: households (HI), non-financial corporations (NFCPC), the financial sector[25] (FC), government[26] (GG) and the rest of the world (W). A banking sector (FC_{MO}) is separated out from the financial sector and non-banking financial institutions[27] (NBFI). According to Zezza and Zezza (2019), a top-down design, orientated towards the proposed research questions, should be the first step for all empirical SFC models. The current setup enables us to model the domestic credit creation process and its impact throughout the domestic economy and to generate what-if scenario simulations for shifts in lending practices/credit standards. We firstly specify the national account version of the SFC stock matrix and then move on to the behavioural equations for the transaction flows.

The notations in the UKSIMM remain the same as those in the Eviews model file presented in Appendix B. Real variables[28] are in small letters and nominal ones are in capital letters[29]. ECM is the main estimation method used in this paper[30]. All data after 2017 are generated by the model simulation.

[25]The banking sector is derived from the financial sector for the credit creation simulation. For future research, a non-bank financial sector will also be derived to capture the role of shadow banking.

[26]The central bank is also included, but its behaviour is greatly simplified. Only the financial balance sheet is presented.

[27]The NBFI is not explicitly modelled in the UKSIMM. Given the importance of the shadow banking sector before the crisis, the interactions between the NBFI and the banking sector will be a major focus of future research.

[28]It refers to the chained volume measures with 2016 as the reference year in the UK 2018 national accounts.

[29]In terms of notation, the Eviews model file assigns real variables with the letter V and nominal variables with the letter N. For example, GDPV is real GDP and GDPN is nominal GDP.

[30]See Section 3.2 for a detailed discussion on ECM.

4.4.1. Sectoral financial balance sheet

UK balance sheet data are detailed in Chapter 9 of the BB. It records all financial assets and liabilities, which are consistent with the stock matrix shown in Tab. 4.2. It should be noted that only the stocks of financial assets and liabilities are discussed in this subsection. The financial account, that is the flow of funds block in Tab. 4.3, is entirely captured by the sectoral net lending positions (FS_t), which is identical to the changes in net financial assets position ($\Delta NFAS_t$) in each sector according to the accounting consistency[31]. The financial account data are available in Chapter 13 of the BB for researchers who are interested in modelling at a more granular level.

The behavioural equations assigned to the sectoral balance sheets thus capture both the volume effects and the revaluation effects. Therefore, the revaluation practice in Tab. 4.4 is treated as residual in the UKSIMM. After taking account of the volume changes, they are implicitly given by the differences between the financial assets/liabilities of two years.

Households (HI)

Households' total financial assets are driven by two behavioural equations and the scenario variable ($MORT^{add}$). The first equation concerns the pension fund assets held by households[32] ($PFUND^{HI}$), which occupies over 50 per cent of households' financial asset portfolios (see Fig. 4.3).

$$\begin{aligned}\Delta ln(PFUND^{HI}) = {} & 4.60 - 0.49 ln(PFUND^{HI}_{-1}) - 0.01 BR_{-1} \\ & - 0.47 ln(\frac{EARN^{priv}_{-1}}{LFSE^{priv}_{-1}}) + 0.16 ln(USA^{SP500}_{-1}) \\ & - 0.02 \triangle(LR) + 0.86 \Delta ln(FAS^{HI}) \end{aligned} \tag{4.2}$$

In (4.2), the pension fund is positively correlated with average earnings in the private sector and US stock market performance, measured using the S&P500 index. Both short-term (BR) and long-term (LR) interest rates have a negative impact, which

[31] In the BB, net lending positions are estimated using income data, while net financial assets positions are estimated using the balance sheet data. Therefore, there are statistical discrepancies between two data series. In the UKSIMM, we introduce a balancing item to ensure that they are identical during the simulation period.

[32] The data consists of insurance, pension and standardised guarantee schemes at current price.

suggests households may divert their financial holdings to other financial assets which offer higher returns. The total financial assets held by households also appear to be positively correlated with household pension funds holdings in the short run.

The second equation (4.3) is assigned to all other financial assets ($FAS^{HI_{EXCL}}$).

$$\begin{aligned}\triangle ln(FAS^{HI_{EXCL}}) = 0.13 - 0.63ln(FAS_{-1}^{HI_{EXCL}}) + 0.57ln(EARN_{-1}^{priv}) \\ + 0.18ln(FTSE_{-1}) + 0.22\triangle ln(FTSE)\end{aligned} \tag{4.3}$$

It is positively correlated to private sector income and UK stock market performance, measured using the FTSE index. The FTSE index is modelled because it measures the revaluation effects in the total financial assets, especially for equity holdings. The index and private earnings are simultaneously determined in the model. It is estimated using (4.4).

$$\begin{aligned}\triangle ln(FTSE) \quad = \quad & -0.05 - 0.26ln(FTSE_{-1}) + 0.09ln(SP500_{-1}^{us}) \\ & +0.11MORT_{-1}^{N} + 0.79\triangle ln(SP500_{-1}^{us}) - 0.15\triangle ln(XR^{usd}) \\ & +0.01\triangle(QE^{us}) - 0.91\triangle ln(EARN^{priv_{avg}}) \\ & -0.80\triangle ln(LFSE_{-1}^{priv}) + 0.11ln(GOS_{-1}^{cos})\end{aligned} \tag{4.4}$$

UK and US capital markets are highly correlated due to the free movement of capital across the Atlantic. Therefore, the FTSE index is found to be positively correlated with the S&P500 index in both the short-run and long-run. The QE index captures the impact of unconventional monetary policy in the UK and US since the GFC. Exchange rate (XR^{usd}) depreciation could impact companies' asset values, and hence appear to have a short-term negative impact. The number of mortgage loans ($MORT^{N}$) appears to have a long-term positive impact on the FTSE index, which may be due to the positive economic boom effects created by credit expansion. As a key variable of interest, in the high mortgage scenario, we would expect it to indirectly contribute to the accumulation of financial assets, other than insurance and pension funds, by the household sector. Additionally, an improvement in the gross operating surplus of the corporate sector (GOS^{cos}) signals strong performance

which has a positive long-term impact on the stock market.

Figure 4.3.: Shares of each financial assets(up) and liability(down), Household

Source: ONS and own calcualtion

Among all the financial assets, cash and deposits, equities, insurance and pensions together account for over 95 per cent of the total financial assets held by households. The trend for each asset has been reasonably stable over many decades (See Fig. 4.3). We conducted an empirical estimation of three separate equations, following the Tobin portfolio allocation system (see (4.1)), for each financial asset held by the household sector using data between 1987 and 2017. Deposit rate and long-term interest rate are treated as the rate of return for bank deposits[33] and insurance and pensions respectively. The rate of return for equities are estimated using the sum of percentage change of the FTSE index and the dividend rate of the non-financial corporation sector. The data contradicts with many of the theoretical predictions. Firstly, although the coefficients for deposit rate have the correct signs in all three equations, none of it shows statistical significance. Secondly, the share of insurance and pension held by households appears to be negatively correlated with the long-term interest rate and the estimated coefficient is also statistically insignificant. Considering the pension funds and insurance companies hold a lion share of treasury bonds in their portfolio, an increase in long-term rate should be associated with rising share of holding of insurance and pension assets under the Tobin portfolio theory. Thirdly, coefficients for the rate of return for equities appear to be positive in all three equations. It has nearly no impacts on the holding of bank deposits.

Therefore, instead of Tobin-type portfolio allocation, the model uses constant shares for each financial asset and liability in the simulation. Such a design not only helps to reduce the model's degree of complexity, but also follows the empirical observations more closely, especially for the household sector.

It should be noted that we have added a high mortgage scenario variable which is explained in detail in sec. 4.5. In the baseline, $MORT^{add}$ is a constant number. A cyclical behaviour will become active when the high mortgage scenario solution is activated.

On the liability side, total liabilities consist of three components: long-term debt ($DEBT^{HI_{lt}}$), which is dominated by mortgages; short-term debt ($DEBT^{HI_{st}}$); and all other debt ($DEBT^{HI_{oth}}$). The repayment rate of $DEBT^{HI_{lt}}$ is around 6 per cent per annum and the inflows are measured using the number of new mortgages ($MORT^{N}$) and the average mortgage advance ($HMEANADV$). Both variables

[33]It excludes the non-interest bearing notes and coins in circulation (M0).

are endogenous and critical for our understanding of the credit cycle. They will be explained in the housing subsection. $DEBT^{HI_{st}}$ is assumed to be 12 per cent of households' previous period disposable income YD^{HI}_{-1}. It mainly includes consumer credit such as credit cards and short-term automobile loans.

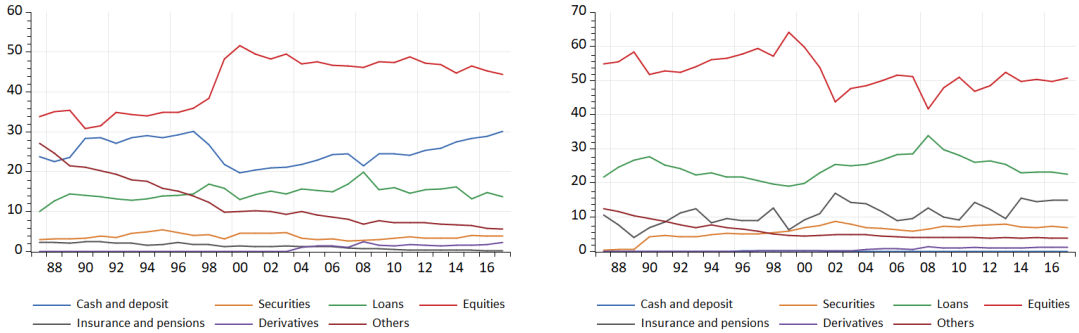
$$\begin{aligned} \triangle DEBT^{HI_{oth}} &= -381551.6 - 0.44DEBT^{HI_{oth}}_{-1} + 0.14gdp_{-1} \\ &\quad +6023.01LR_{-1} + 21.58POP^{65}_{-1} + 0.22\triangle gdp \end{aligned} \tag{4.5}$$

Other household debt consists of all other liabilities. It is positively related to real GDP growth and the long-term interest rate (LR_{-1}). The long-term interest rate also serves as the basis for the interest rates applied to other forms of household debts, its positive coefficient thus suggests that a higher interest rate leads to more debt service payments and an increasing stock level for other debt instruments. Other household debts also appear to be positively correlated with the population aged over 65 in the UK. The positive correlation between the elderly population and all forms of household debts is also evident in the US (Li, 2019).

In Tab. 4.5, around 65 per cent of $DEBT^{HI_{oth}}$ is assigned to loan liabilities ($\beta = 0.65$). The remaining 35 per cent is shared between insurance, pensions and other liabilities. In the baseline, we assume 60 per cent of such remaining ends up in holding pensions and insurance ($\alpha = 0.6$).

Non-financial corporations[34] (NFCPC)

Figure 4.4.: Shares of each financial assets(left) and liability(right), NFCPC



Source: ONS and own calcualtion

Changes in total financial assets (FAS^{NFCPC}) depend on the growth of the nominal GDP. On the asset side of the balance sheet, cash and deposits ($M4A^{NFCPC}$) are subject to change in the simulation. The high mortgage scenario will stimulate additional investment from households into housing, therefore, some of the mortgage lending ($\delta = 0.25$) will end up in the accounts of real estate or construction companies as payments from the household sector (see (4.6)).

$$FAS^{NFCPC} = \frac{GDP}{GDP_{-1}} FAS^{NFCPC}_{-1} + \delta MORT^{add} \tag{4.6}$$

In the baseline scenario, all assets have constant shares relative to total assets throughout the simulation periods. With additional inflows coming in as $M4A^{NFCPC}$, the portfolio composition will be altered. Other assets are estimated according to their previous shares, as in the baseline scenario, to ensure the adding-up constraint is adhered to (see Tab. 4.5).

Total liabilities are the sum of all of the sub-components of financial liabilities. Like the household sector, there are no cash liabilities for the NFCPC sector. Apart from equities, all other liabilities are estimated based on their historical shares and the previous level of liabilities. Equities grow at the same rate as the accumulation of the stock of non-financial assets in the NFCPC sector.

[34]Public corporations are also included in this sector. Hence the acronym NFCPC

Table 4.5.: Sectoral balance sheets - UKSIMM equations

	Households (HI)	**Non-financial corporations** ($NFCPC$)	**Financial corporations** (FC)	**Government** (GG)	**Central bank** (FC_{CB})	**Rest of the world** (W)
			Financial Assets (A)			
Cash and deposit ($M4$)	$\frac{M4A^{HI}_{-1}}{FAS^{HI}_{-1}}(FAS^{HI}-0.75MORT^{ADD})+0.75MORT^{ADD}$	$0.3(FAS^{NFCPC}-0.25MORT^{ADD})+0.25MORT^{ADD}$	$0.241FAS^{FC}$	$0.14FAS^{GG}$	$\frac{M4A^{FC_{CB}}_{-1}}{FAS^{FC_{CB}}_{-1}}FAS^{FC_{CB}}$	$\frac{M4A^{W}_{-1}}{FAS^{W}_{-1}}FAS^{W}$
Securities (DS)	$\frac{DSA^{HI}_{-1}}{FAS^{HI}_{-1}}(FAS^{HI}-0.75MORT^{ADD})$	$0.04(FAS^{NFCPC}-0.25MORT^{ADD})$	$0.131FAS^{FC}$	$0.12FAS^{GG}$	*Residual*	$\frac{DSA^{W}_{-1}}{FAS^{W}_{-1}}FAS^{W}$
Loans (L)	$\frac{LA^{HI}_{-1}}{FAS^{HI}_{-1}}(FAS^{HI}-0.75MORT^{ADD})$	$0.14(FAS^{NFCPC}-0.25MORT^{ADD})$	$0.22FAS^{FC}$	$0.33FAS^{GG}$	$\frac{LA^{FC_{CB}}_{-1}}{FAS^{FC_{CB}}_{-1}}FAS^{FC_{CB}}$	$\frac{LA^{W}_{-1}}{FAS^{W}_{-1}}FAS^{W}$
Equities (ST)	$\frac{STA^{HI}_{-1}}{FAS^{HI}_{-1}}(FAS^{HI}-0.75MORT^{ADD})$	$0.44(FAS^{NFCPC}-0.25MORT^{ADD})$	$0.16FAS^{FC}$	$0.25FAS^{GG}$	$\frac{STA^{FC_{CB}}_{-1}}{FAS^{FC_{CB}}_{-1}}FAS^{FC_{CB}}\frac{FTSE}{FTSE_{-1}}$	$\frac{STA^{W}_{-1}}{FAS^{W}_{-1}}FAS^{W}$
Insurance and pensions (IP)	$\frac{IPA^{HI}_{-1}}{FAS^{HI}_{-1}}(FAS^{HI}-0.75MORT^{ADD})$	$0.002(FAS^{NFCPC}-0.25MORT^{ADD})$	$0.0562FAS^{FC}$	0	$\frac{IPA^{FC_{CB}}_{-1}}{FAS^{FC_{CB}}_{-1}}FAS^{FC_{CB}}$	$\frac{IPA^{W}_{-1}}{FAS^{W}_{-1}}FAS^{W}$
Derivatives (DER)	$\frac{DERA^{HI}_{-1}}{FAS^{HI}_{-1}}(FAS^{HI}-0.75MORT^{ADD})$	$0.02(FAS^{NFCPC}-0.25MORT^{ADD})$	$0.19FAS^{FC}$	0	$\frac{DERA^{FC_{CB}}_{-1}}{FAS^{FC_{CB}}_{-1}}FAS^{FC_{CB}}$	$\frac{DERA^{W}_{-1}}{FAS^{W}_{-1}}FAS^{W}$
Others (OAR)	$\frac{OARA^{HI}_{-1}}{FAS^{HI}_{-1}}(FAS^{HI}-0.75MORT^{ADD})$	$0.0598(FAS^{NFCPC}-0.25MORT^{ADD})$	$0.0024FAS^{FC}$	$0.16FAS^{GG}$	$\frac{OARA^{FC_{CB}}_{-1}}{FAS^{FC_{CB}}_{-1}}FAS^{FC_{CB}}$	$\frac{OARA^{W}_{-1}}{FAS^{W}_{-1}}FAS^{W}$
			Financial liabilities (L)			
Cash and deposit ($M4$)	0	0	$-0.33FLS^{FC}$	0	$RESV+NOTES$	$-0.25FLS^{W}$
Securities (DS)	0	$-0.075FLS^{NFCPC}_{-1}$	$-0.09FLS^{FC}$	$DSL^{GG}_{-1}+FS^{GG}$	$\frac{DSL^{FC_{CB}}_{-1}}{FLS^{FC_{CB}}_{-1}}FLS^{FC_{CB}}$	$-0.09FLS^{W}$
Loans (L)	$D^{HI_{LT}}+D^{HI_{ST}}+\beta D^{HI_{OTH}}$	$-0.24FLS^{NFCPC}_{-1}$	$-0.075FLS^{FC}$	$LL^{GG}\frac{GDPP}{GDPP_{-1}}$	$\frac{LL^{FC_{CB}}_{-1}}{FLS^{FC_{CB}}_{-1}}FLS^{FC_{CB}}(1+lr)$	$-0.17FLS^{W}$
Equities (ST)	0	$STL^{NFCPC}_{-1}\frac{KIVL^{NFCPC}}{KIVL^{NFCPC}_{-1}}$	$-0.115FLS^{FC}$	0	$\frac{STL^{FC_{CB}}_{-1}}{FLS^{FC_{CB}}_{-1}}FLS^{FC_{CB}}\frac{FTSE}{FTSE_{-1}}$	$-0.28FLS^{W}$
Insurance and pensions (IP)	$\alpha(1-\beta)D^{HI_{OTH}}$	$-0.155FLS^{NFCPC}_{-1}$	$-0.18FLS^{FC}$	IP^{GG}_{-1}	$\frac{IPL^{FC_{CB}}_{-1}}{FLS^{FC_{CB}}_{-1}}FLS^{FC_{CB}}$	0
Derivatives (DER)	0	$-0.012FLS^{NFCPC}_{-1}$	$-0.18FLS^{FC}$	DER^{GG}_{-1}	$DERA^{FC_{CB}}$	$-0.19FLS^{W}$
Others (OAR)	$(1-\alpha)(1-\beta)D^{HO_{OTH}}$	$-0.04FLS^{NFCPC}_{-1}$	$-0.003FLS^{FC}$	$OARL^{GG}_{-1}\frac{GDPP}{GDPP_{-1}}$	$\frac{OARL^{FC_{CB}}_{-1}}{FLS^{FC_{CB}}_{-1}}FLS^{FC_{CB}}$	$-0.001FLSN_{W}$

Financial corporations (FC)

The total financial assets of financial corporations grow at the same rate as the GDP deflator. Net lending positions are also incorporated into their total assets. Their financial liabilities are assumed to be equal to the total assets, hence the net financial asset position is zero in the simulation. Specific shares based on 2017 data are given to each type of financial asset and liability.

As explained later in sec. 4.4.9 and sec. 4.5, further research is needed to be able to better model financial flows within the FC sector. According to Burrows et al. (2015), the balance sheet of the semi-banking sector[35] in the UK may be as large as £590 billion, which is around 8 per cent of the overall banking sector, using 2014 data.

Government and central bank (GG, FC_{CB})

Changes in the value of total financial assets held by the government sector are mainly the result of revaluation effects, which are captured by growth of the GDP deflator ($GDPP/GDPP_{-1}$). All the other financial assets grow at the same rate as total financial assets and are assumed to maintain their 2017 shares relative to the total.

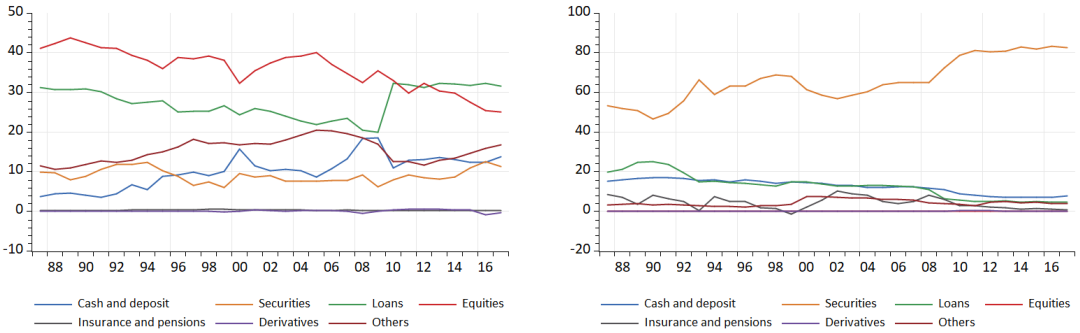
Debt securities (DSL^{GG}) dominate the liability side. They are the major financing instrument used by the government sector to meet its deficit demand. Hence the net lending position (FS^{GG}) is entirely financed by the net flows of securities, $DSL^{GG} = DSL^{GG}_{-1} + FS^{GG}$. As shown by Fig. 4.5, the shares of other liabilities are dwarfed by government securities. Loan liabilities (LL^{GG}) and other liabilities ($OARL^{GG}$) are also assumed to grow at the same rate as $GDPP$, while derivatives, insurance and pensions are constant at the 2017 level.

Unlike the other sectors in the BB, the central bank balance sheet is not readily available, as it is recorded under the financial corporation (FC) sector. Therefore, the balance sheet data are gathered through the Bank of England's annual reports[36] and presented in Fig. 4.6. The balance sheet data then have to be deducted from the balance sheet of the FC in the national accounts to avoid double counting.

[35] It mainly includes securitisation special purpose vehicles (SPVs) and finance companies, which are often owned by banks

[36] We thank Cam Bowie for his help gathering UK balance sheet and transaction flow data.

Figure 4.5.: Shares of financial assets (left) and liabilities (right), government sector



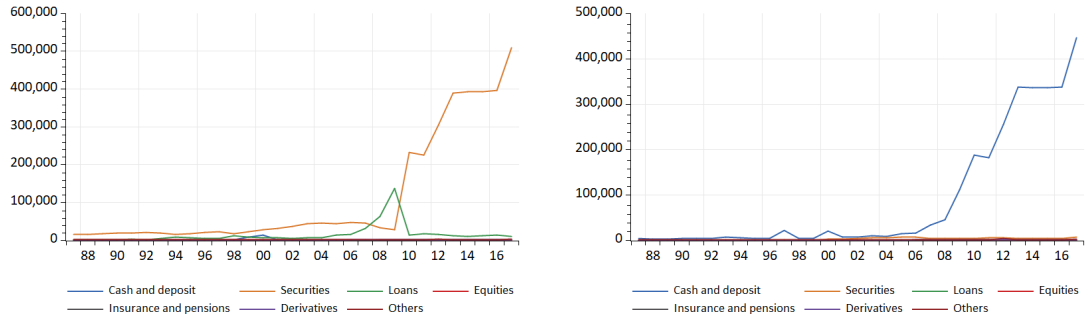
Source: ONS, created by the author

The financial assets and liabilities are given in absolute values instead of shares so that the massive expansion of the BoE's balance sheet after the GFC can be observed. This expansion is the direct result of Quantitative Easing (QE), when after 2008, in order to stimulate the economy, massive amounts of cash and deposits were created by the Bank in exchange for securities with the private sector.

Based on the current balance pattern, the UKSIMM assumes the total financial assets of the Bank ($FAS^{FC_{CB}}$) remain 20 per cent larger than its liabilities ($FLS^{FC_{CB}}$) throughout the simulation periods. Consequently, its growth trajectory follows the dynamics of $FLS^{FC_{CB}}$. Most of the assets follow the growth trend of $FAS^{FC_{CB}}$ by fixing their shares at the 2017 level. Equities holdings also respond to the general trend in the stock market, represented by the $FTSE$ index. Although debt securities are treated as residual, given the historical shares of other asset holdings, they remain the dominant financial asset on the balance sheet.

On the liability side, cash and money deposits ($M4L^{FC_{CB}}$) consist of notes issued by the BoE and reserves from commercial banks. The supply of bank notes increases at the same rate as nominal GDP (GDP/GDP_{-1}). Commercial bank reserves are exogenous and held constant at the 2017 level. This is another key policy variable. For example, the impact of QE across the economy can be simulated through a rapid expansion of this variable. Therefore, in the baseline, the expansion of the BoE's balance sheet is mainly driven by GDP growth.

Figure 4.6.: Financial assets (left) and liabilities (right), central bank



Source: ONS, created by the author

Shares and equities on the liability side also react to the general trend of the stock market. Also, debt security liabilities are accumulated through interest payments. There are no additional behavioural assumptions assigned to the other liabilities.

External sector

The net financial assets ($NFAS^W$) of the external sector are treated as a horizontal residual in the UKSIMM. In Tab. 4.2, we have shown that the net financial assets across all sectors in the economy must add up to zero. The same principle applies here, therefore, we have

$$NFAS^W = 0 - NFAS^{GG} - NFAS^{NFCPC} - NFAS^{FC} - NFAS^{HI} - NFAS^{FC_{CB}} \tag{4.7}$$

Over past decades, the value of total financial assets of the external sector (FAS^W) has ranged between 80 per cent and 110 per cent of the value of total financial liabilities (FLS^W). Given the $NFAS^W$ is strictly negative[37] and it is the net value between total assets and total liabilities, $FASN^W$ is assigned to be 80 per cent (or any value that is below 100 per cent) of the $FLSN^W$ to ensure this condition holds in the model. Therefore, we can derive the function of total liabilities[38] as

[37] In reality, the $NFASN^W$ can also be positive. The strict negative values in the model are a result of positive net positions projected for the other sectors in the economy.

[38] Total liabilities in the UKSIMM model file are negative values, while each financial liability is in positive.

$FLSN^W = -\frac{NFASN^W}{0.2}$ in the model. Each financial asset and liability is estimated, using 2017 data as the reference, based on the constant shares approach.

4.4.2. GDP components

Real GDP, measured using the expenditure approach, is the sum of final consumption expenditure, gross capital formation and the external balance of goods and services. The final consumption expenditure consists of final consumption from households (c^{HI}) and the government (c^{GG}). Gross capital formation captures[39] the changes in real gross fixed capital formation ($\triangle k$) and changes in inventories ($\triangle in$). Real output is also divided into private sector (gdp^{priv}) and public sector (gdp^{pub}) categories. Nominal GDP (GDP) is derived by multiplying real GDP with the GDP deflator ($GDPP$)[40].

$$gdp = c + i + (x - m) = (c^h + c^g) + (\triangle k + \triangle in) + (x - m) \tag{4.8}$$

Final consumption expenditure

The final consumption expenditure function[41] for households (c^h) is estimated using the ECM method. It is consistent with the US consumption model and the consumption function in the UKMOD developed by Gudgin et al. (2015)

$$\begin{aligned} c^{HI} &= 139196.73 - 0.54c^{HI}_{-1} + 0.26yd^{HI}_{-1} + 0.04fas^{HI}_{-1} + \beta_5 \frac{DEBT^{HI}_{-1}}{YD^{HI}_{-1}} \\ &\quad +0.03MORT^N(hmeanadv) + 151887.04R^{mrepay}_{-1} + 1065.98R^{mort}_{-1} + 0.14\triangle yd^{HI} \\ &\quad -22.678\triangle debt^{HI_{st}} + 12.36\triangle debt^{HI_{lt}} + 115803.61\triangle ln(hp) + 1.52\triangle fas^{HI} \end{aligned} \tag{4.9}$$

As expected, all coefficients are statistically significant and the error correction coefficient is -0.54, which indicates convergence towards the long-run equilibrium.

[39] Strictly speaking it should also include the net acquisition of valuables, which records transactions of gemstones, precious metals (except gold) and valuable paintings. However, this value is negligible. For example, the share of the net acquisition of valuables within gross capital formation in the UK is less than 0.1 per cent.

[40] $gdpp = GDPP/100$,the same format applies to all other deflators in the thesis

[41] The parameters in (4.9) are estimated using data between 1975 and 2017.

Real household consumption is positively correlated with the real disposable income (yd^{HI}) and financial wealth level (fas^{HI}). The previous credit standard variable for the US is replaced by $MORT^{N}$ and average mortgage advances ($hmeanadv$) at constant price. The positive relationship is evident from the estimated coefficient (0.03). The mortgage repayment rate[42] R^{mrepay} and mortgage interest rate R^{mort} have a negative impact on household consumption, as both require more income to service debt.

The coefficients for the short-term debt liability variable ($debt^{HI}$) also appear to be negative in the short-run and the long-run, which is identical to the US results. The housing wealth effect and access to long-term debt, represented by the growth rate of real house prices and the net change in real long-term debt liabilities, have a significant positive impact on household consumption over the short-run.

The real consumption of the government sector (c^{GG}) is treated as an exogenous policy variable, growing at a constant rate of 2 per cent, which can be changed based on different fiscal policy scenarios. The same consumption defaltor is applied to both the household and government sectors. It grows at an exogenous rate of 1 per cent.

Gross capital formation

The change in gross fixed capital formation[43] ($\triangle k$) is further divided into investments in the household sector ($\triangle k^{HI}$), the corporate sector ($\triangle k^{COS}$), and the government sector ($\triangle k^{GG}$).

$$\triangle k = \triangle k^{HI} + \triangle k^{COS} + \triangle k^{GG} \tag{4.10}$$

$\triangle k^{COS}$ and $\triangle k^{GG}$ are assumed to grow at an exogenous rate of 3 per cent in the model, given the variable of interest is $\triangle k^{HI}$, which consists of the purchase of dwellings. $\triangle k^{COS}$ can be further divided into two subcategories: the non-financial corporate sector ($\triangle k^{NFCPC}$) and the financial sector ($\triangle k^{FC}$). The baseline household investment function[44] is given by (4.11),

[42]For simplicity, it is assumed to be constant at the 2017 level in the simulation. It limits the negative impact of debt servicing to the mortgage interest rate channel.

[43]It is the net acquisition of produced fixed assets, which include both tangible assets (e.g. dwellings) and intangible assets (e.g. software).

[44]It is subject to modification in the simulation section to respond to a credit boom.

$$\triangle ln(\triangle k^{HI}) = 3.95 - 0.35 ln(\triangle k^{HI}_{-1}) + 0.005 R^{mort}_{-1} + 0.25 \frac{MORT^{add}}{gdpp} + 0.51 \triangle ln(\frac{HB^{priv} \cdot HP^{mean}}{YD^{HI}}) \quad (4.11)$$

where HB^{priv} is private sector house building and HP^{mean} is the average house price in the UK. Given that a considerable amount of household investment is in residential buildings, it is thus positively associated with the stock-flow ratio between the increased housing wealth and household disposable income, in the short run. A higher ratio signaling a better rate of return for investment, is likely to attract more fixed investment. The mortgage rate R^{mort}, as a cost of access to financing, has a negative impact on household gross fixed capital formation in the long-run. The high-mortgage scenario variable $MORT^{add}$ is added into households' investment function, which means around a quarter of the additional mortgage liabilities are used for household investment in residential buildings. This adds the new housing to the current stock and mortgage lending will end up as cash payments to construction and real estate companies as reflected in $M4A^{NFCPC}$.

Stockbuilding or changes in inventories ($\triangle in$) is another important component of gross capital formation. This includes material inputs, finished goods for sale or resale and strategic stocks such as oil and food items. Stockbuiding can be a good indicator of investor confidence about future growth, should there be a positive increase in the material inventory. This is indeed the case in the UK where it is positively correlated with changes in private sector GDP (gdp^{priv}) in (4.12). However, a negative sign is possible when most of the inventories accumulated are finished products - a sign of an economic downturn.

$$\begin{aligned} \triangle^2 in &= 87.95 - 0.71 \triangle in_{-1} + 0.18 \triangle gdp^{priv} \\ &\quad -2080.96 \triangle (CP^m) \end{aligned} \quad (4.12)$$

The nominal value of inventories takes both the GDP deflator growth and import price growth into account, given that the prices of many strategic stocks such as oil are reflected in import prices. Stockbuilding of the UK household sector is

approximately 0.25% of the real GVA in 2017 and the nominal value is about 0.1% of household GVA. The stockbuilding of the UK public sector is negligible.

External balance of goods and services

The external balance of goods and services coincide with the trade balance in the current account. Export volumes are assumed to grow at 2 per cent per annum, and as a small open economy, this can be expected to be driven by the GDP growth of key trading partners. Therefore, it is treated as an exogenous variable, although other factors such as the real exchange rate, real imports, domestic inflation and real interest can be expected to have some impact. The assumption is 1 per cent below the average between 2000 and 2017, which reflects a conservative view on UK export performance after Brexit.

The import volume equation is given by (4.13),

$$\begin{aligned}\triangle ln(m) = &-6.73 - 0.71ln(m_{-1}) + 0.78ln(c^{HI}_{-1}) + 0.23ln(x_{-1}) \\ &+ 0.09ln(c^{GG}_{-1}) + 0.07ln(\triangle k^{COS}_{-1}) + 1.66\triangle ln(gdp^{dom}) \\ &+ 0.46\triangle ln(x) - 0.05ln(\frac{LFSE^{un}_{-1}}{POP^{w}_{-1}})\end{aligned} \tag{4.13}$$

where $\frac{LFSE^{un}_{-1}}{POP^{w}_{-1}}$ is the share of unemployment within the total working-age population and gdp^{dom} is total domestic consumption and investment expenditure. The import function is mainly driven by domestic demand. In the long-run, the coefficients for domestic consumption and investment are all highly significant and appear to have the expected positive sign. Import elasticities differ considerably among domestic demand components. Import propensity is found to be highest for household consumption c^{HI} ($|\frac{0.87}{-0.89}| = 0.97$) in the UK. There is also a high degree of positive correlation between UK export volumes and the import volumes in both the long and short runs, which may have captured the positive effects from the imports of intermediate inputs for the UK exporters. A high unemployment ratio not only coincides with low levels of capacity utlitisation but also reduces household income and consumption demand. Hence it is negatively related to import growth in the short-run dynamics. Although the estimated coefficient for the relative price between import price (MP) and domestic producer price ($GDPP$) has a negative sign as theory predicts, it appears to be statistically insignificant even at the 10 per cent

level. Therefore, the relative price term is not included in the equation.

4.4.3. Prices

This section specifies all the price dynamics in the UKSIMM. It also includes the interest rates and exchange rate equations. There are five endogenous variables, which will be described in detail. They are the long-term interest rate (LR), the consumption deflator (CP^m), the export price (XP), import price (MP) and exchange rate ($EFXI$). The GDP deflator is estimated using an ARDL equation that consists of all other major deflators in the model. For simplicity, the deflator for gross capital formation is set equal to the GDP deflator in the model. The short-term interest rate is a monetary policy variable controlled directly by the Bank of England (BoE), which sets the base for all other interest rates in the market.

Unlike the endogenous mark-up applied by Godley and Lavoie (2012), the mortgage rate is assumed to add a fixed mark-up on long-term interest rates, LR, which is the yield of 10-year government bonds in the UK. The LR is estimated based on consumer price inflation and short-term interest rates in both the US and UK. It seems likely that trans-Atlantic capital market arbitrage could be the reason behind the strong co-movements of interest rates in the US and UK.

In terms of prices, the consumption deflator is a critical measure of inflation in the model. It is thus an explanatory variable for LR and exchange rate. There are both domestic and external drivers of the consumption deflator. On one hand, domestic private sector earnings and labour productivity can influence consumption deflation through wages. On the other hand, given that the UK economy is a small open economy, an increase in either world oil prices or import prices can infuse inflation into the domestic economy.

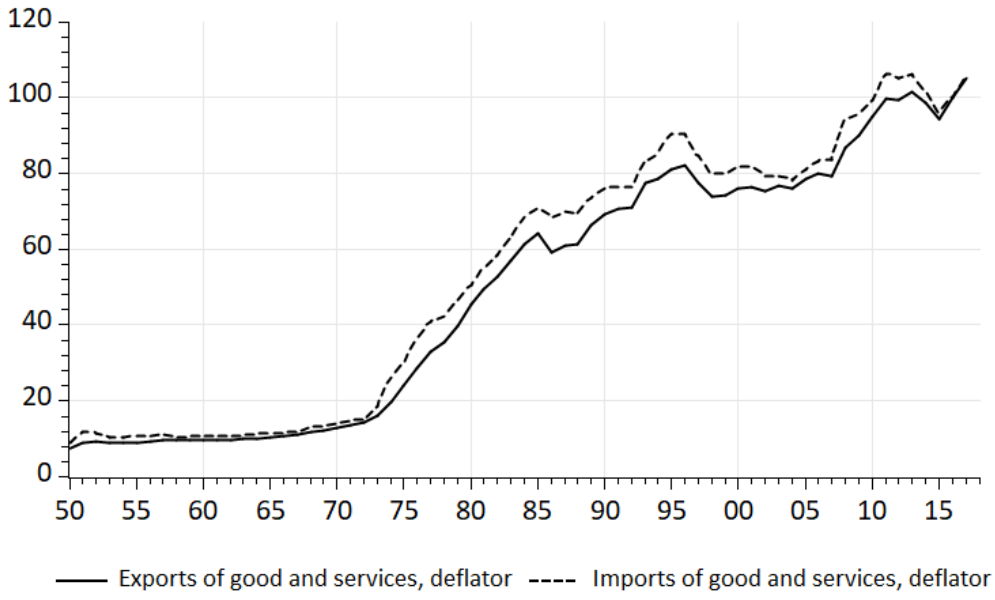
$$\begin{aligned} \triangle ln(CP^m) &= 0.58 - 0.32ln(CP^m_{-1}) + 0.25ln(EARN^{priv_{awe}}_{-1}) + 0.11ln(MP_{-1}) \\ &\quad -0.27ln(gdp^{priv}/L^{priv}_{-1}) + 0.12\triangle ln(MP) + 0.10\triangle ln(W^{min}_{-1}) \\ &\quad +0.47\triangle ln(EARN^{priv_{avg}}) + 0.003\triangle ln(P^{oil}) \end{aligned} \tag{4.14}$$

$$\begin{aligned}\triangle ln(MP) &= 1.59 - 0.19 * ln(MP_{-1}) - 0.19 * ln(XR^{ef}_{-1}) + 0.02 * ln(P^{oil}_{-1}) \\ &\quad +0.05 * \triangle ln(P^{wrm}_{-1}) + 0.04 * \triangle ln(P^{oil}) - 0.70 * \triangle (XR^{ef}) \\ &\quad +0.25 * \triangle ln(WTI) \end{aligned} \tag{4.15}$$

The price indices for imports and exports (in logarithm) are determined by (4.15) and (4.16). Effective exchange rates and world oil prices appear to be statistically significant in influencing the import price index in the long-run and short-run. Other short-run influences come from world raw material prices and movements in world trade volumes.

$$\begin{aligned} ln(XP) &= 0.008 + 0.94 ln(XP_{-1}) - 0.13 ln(XP_{-2}) \\ &\quad + 0.63 ln(MP) - 0.44 ln(MP_{-1}) \end{aligned} \tag{4.16}$$

Figure 4.7.: Co-movement of the export price and import price in the UK



Source: ONS

There is a strong co-movement observed in the UK between export prices and import prices (See Fig. 4.7). Having specified the import price equation, the export price equation is essentially an ARDL type equation with only lagged values of export and import prices as independent variables in the UKSIMM.

$$\begin{aligned}\triangle LR = &-0.98 - 0.04LR_{-1} + 0.01EFXI_{-1} \\ &+ 0.17\triangle BR + 0.22\triangle BR^{usa}\end{aligned} \tag{4.17}$$

In (4.17), the short-term interest rates in the UK (BR) the US (BR^{usa}) , which are proxies of the policy rate, seem to have a significant positive impacts on LR in the short run. This is not surprising given both countries have an open capital account, the comovement of interest rates is expected. The effective exchange rate ($EFXI$)[45] is the only level variable that shows statistical significance. It confirms that, under the flexible exchange rate regime, the interest rate differentials across the Atlantic indeed positively correlate with exchange rate movements between two currencies over the long term.

The effective exchange rate equation is given by (4.18). The equation complies with basic economic principles such as the purchasing power parity (PPP). When the lagged UK inflation level ($\triangle ln(CP^{M}_{-1})$) exceeds the US ($\triangle ln(CP^{US_m}_{-1})$), it has depreciating pressure on Sterling. Also, an improvement in the lagged trade balance as a share of GDP ($\frac{(X_{-1}-M_{-1})}{GDP_{-1}}$), or a positive differential between domestic long-term interest rate and US long-term interest rate is associated with currency appreciation as expected for countries with a floating exchange rate regime. $\triangle WTI$ is the world trade index[46]. In the simulation periods, the index essentially acts as a trend factor which is growing at 4 per cent per year.

$$\begin{aligned}\Delta ln(EFXI) = &\ 0.34 - 0.07ln(EFXI(-1)) - 0.01(\triangle ln(CP^{M}_{-1}) - \triangle ln(CP^{US_m}_{-1})) \\ &+ 0.007\triangle WTI + 0.02\frac{(X_{-1} - M_{-1})}{GDP_{-1}} \\ &+ 0.02(LR_{-1} - LR^{US}_{-1})\end{aligned} \tag{4.18}$$

[45] An increase(decrease) in $EFXI$ indicates that sterling appreciates(depreciates) against the US dollar.

[46] The index is a volume index for global trade. It is calculated by Oxford Economics.

Although international capital flows are expected to have direct impacts on exchange rates in theory, none of the UK capital flows measures[47] appears to show statistical significance in the model. The impacts might have been partially accounted by the interest differentials between the UK and the US. Forecasting exchange rate movements with any degree of accuracy in a macroeconomic model is almost impossible. The current equation is still under development.

4.4.4. Employment and Population

Labour market

The labour market is divided into the private sector ($LFSE^{priv}$) and public sector ($LFSE^{pub}$). Projections for each segment together with nominal earnings will produce estimates for wages and salaries, which are essential in estimating personal incomes, income taxes, and national insurance contributions. The private sector labour force equation is given by (4.19), which is mainly demand driven.

$$\begin{aligned} \triangle LFSE^{priv} &= 8948.14 - 0.38LFSE^{priv}_{-1} + 0.002gdp - 0.002kivl^{COS}_{-1} - 173.73BR_{-1} \\ &\quad +0.01\triangle kivl^{COS}_{-1} + 0.006VAT^{REG}_{-1} - 0.003VAT^{DEREG}_{-1} \end{aligned} \tag{4.19}$$

Apart from real GDP, private sector labour demand is positively related to private investment from firms. This is captured by the net acquisition of non-financial assets ($\triangle kivl^{COS}$) at a constant price and the number of firms in the market, represented by the VAT registration and deregistration number (VAT^{REG} and VAT^{DEREG}) in the long-run. The inclusion of short-term interest rates reflects the impacts of repayment costs over existing debt stocks on private sector employment. Lower interest rates allow firms to retain more post-interest profits, which will have a positive impact on employment. Firms' demand for labour is well captured, especially the unexpected increase since 2009, by the change in the number of firms registered for VAT[48]. Private sector labour is further divided into self-employed (17.8 per cent) and employees (82.2 per cent) based on 2017 data.

[47] It includes total capital inflows (ΔFLS^w), total capital outflows (ΔFAS^w) and net capital inflows.

[48] The number of firms registered and deregistered for VAT is assumed to be constant at the last available data point.

$$\begin{aligned}\triangle ln(LFSE^{pub}) &= 0.38 - 0.45ln(LFSE^{pub}_{-1}) + 0.36ln(c^{GG}_{-1}) - 0.14ln(\frac{kivl^{GG}_{-1}}{LFSE^{pub}_{-1}}) \\ &\quad -0.10ln(\frac{gdp^{priv}_{-1}}{LFSE^{priv}_{-1}}) + 0.57\triangle ln(c^{GG}) \\ &\quad -0.24\triangle ln(gdp_{-1}) \end{aligned} \tag{4.20}$$

The positive impact of real public consumption (c^{GG}) expenditures on demand for public employment can be witnessed in both the short-run and long-run in (4.20). The $kivl^{GG}$ is adjusted by $LFSE^{GG}$, which acts as a proxy of the demand for public investment expenditures, which is negatively related to public employment. That is, the lower the non-financial assets per head, the more public investment that is needed. Real GDP growth and private sector productivity growth both have a negative impact and this might be the result of competition for labour from the private sector.

The unemployment equation is given by (4.21),

$$\begin{aligned}\triangle LFSU &= 1318.40 - 0.20LFSU_{-1} - 0.05LFSE^{priv}_{-1} + 0.98MIG^{w}_{-1} \\ &\quad -0.80\triangle LFSE^{pub} + 1.32\triangle LFSE^{65} - 0.46\triangle LFSE^{priv} \\ &\quad -44.13\triangle SR + 23.88\triangle ln(CP^{M}) \\ &\quad +9467.86\frac{WAGE^{min}_{-1}}{EARNING^{priv_{awe}}_{-1}} \end{aligned} \tag{4.21}$$

In the long-run, the strong performance of the private sector will decrease the number of unemployed in the economy, while an increase in migrant workers and the ratio of the minimum wage to private sector earnings displays replacement effects. Public sector employment and monetary policy can have a significant impact on reducing unemployment in the short-run. People who are still beyond the retirement age seem to have a short-term crowding-out effect.

Population

The trend of natural population growth is around 1 per cent per year. Slightly

faster growth is assigned to people aged over 65, which is consistent with the aging demographic profile of the UK. This has implications for the social benefits paid by the government sector. The working-age (defined as ages 15 to 64) population is dependent on its previous stock value and the net number of incoming migrant workers. This is estimated as a fixed share of real GDP, but it can be treated as another exogenous policy variable given that immigration policy may change substantially after Brexit.

4.4.5. Households

The household sector is one of the most comprehensively modelled sectors in the UKSIMM, given its importance in understanding the financial crisis. Tab. 4.6 is useful in illustrating how transaction flows in the national accounts (Tab. 4.3) are modelled and how the net lending/borrowing positions (FS) are calculated. FS is the variable that connects the transaction flows with the balance sheets presented in Tab. 4.5. The same procedure applies to all sectors in the UK with only minor modifications. In this subsection, we use the household sector as an example to illustrate how the net lending/borrowing position is derived in the national accounts.

The GVA of the household sector[49], which corresponds to the first line in the primary distribution of the income account (BB Table 6.1.2) in Tab. 4.6, is assumed to be 21 per cent of total GVA in the model. It thus follows the trend of estimated GDP growth. To derive the gross operating surplus ($GOS^{HI}MIX$)[50], we need to deduct compensation to employees, paid ($COMPH^{HI}$) and taxes less subsidies on production other than products ($IT^{PDTN_{hi}} - SUB^{PDTN_{hi}}$) from households' GVA. $COMPH^{HI}$ is 1.23 times the annual wage bill[51] and the wage bill in turn follows a weighted growth trend of households GVA. ($IT^{PDTN_{hi}} - SUB^{PDTN_{hi}}$) is roughly -0.5 per cent of the household sector. These coefficients are calculated based on the latest available data in the BB (i.e., 2017 data).

After deriving the GOS^{HI}, we can move to the allocation of primary income account in Tab. 4.6 (BB Table 6.1.3). The balance of gross primary income requires

[49]Non-profit institutions serving households (NPISH) are also included.

[50]For households, it also contains gross mixed incomes, these are incomes paid for the work carried out in the NPISH sector, which only applies to the household sector in the UKSIMM.

[51]The ratio between the overall compensation of employees and wages and salaries remained relatively stable between 1987 and 2017, with a minimum ratio of 1.19 and a maximum of 1.25.

Table 4.6.: Deriving net lending/borrowing position in the UK national accounts

Accounts in the UK blue book	Accounting items	UKSIMM Code
Primary distribution of income account	GVA	GVA
	Compensation of employees, use (-)	COMPH
	Taxes on production other than products (-)	IT
	Subsidies on production other than products (+)	SUB
	Gross operating surplus (=)	GOS
Allocation of primary income account	Compensation of employees, resource (+)	COMP
	Property incomes received (+)	PIC
	Property incomes paid (-)	PID
	Gross primary incomes (=)	YP
Secondary distribution of income account	Net social contributions (-/+)	ECC
	Net social benefits (-/+)	SBF
	Taxes on income and wealth (-/+)	TTAX
	Net current transfers (+)	OCTB
	Gross disposable income (=)	YD
Use of disposable income account	(Consumption expenditure (-))	C
	Gross savings (=)	SAVINGS
Accumulation accounting - capital account	Net capital transfers (+)	OKTB
	Gross capital formation (-)	DK
	Changes in inventories (-)	DIN
	Net acquisition of valuables (-)	DV
	Net acquisition of non-produced non-financial assets (-)	DL
	Net lending and borrowing position (=)	FS
Adding to financial balance sheets (or stock matrix)		

Source: created by the author

that income resources are further added, such as compensation to employees, received[52] ($COMP^{HI}$) and net property incomes[53] ($\lambda^{HI} FAS_{-1}^{HI} - brDEBT_{-1}^{HI}$). A capital return coefficient (λ^{HI}) and the short-term interest rate (br) are assigned to total financial assets and total debt liabilities respectively to estimate the property incomes received and paid. Other current transfers are economic transactions of goods, services, and financial items received that expect nothing in return. It follows the dynamics of the consumption deflator.

Secondary distribution of income account in Tab. 4.6 is consistent with the BB Table 6.1.4. It should be noted that in the table, the addition or subtraction of an item depends on which sector is of interest. This is the result of a double-entry system design in the national accounts and is fully consistent with the SFC approach - an inflow in one sector is matched by an equivalent amount of outflow in another. In our case, households receive social benefits[54] ($+SBF^{HI}$) from either the public or

[52]This is the income received through direct participation in the production process.
[53]It includes interest payments, dividends, rents etc.
[54]This item is estimated separately for the public and private sectors. The former grows in line

private sector, at the same time, they are also liable to pay for social contributions[55] ($-ECC^{HI}$) and to pay taxes on income and wealth[56] ($-TTAX^{HI}$). The opposite is true for the corporate and the government sectors.

Once gross disposable income YD^{HI} is estimated, we can calculate the gross savings $SAVING^{HI}$ by subtracting households' consumption expenditures (C^{HI}) in the use of disposable income account[57]. It should be noted that, in some sectors, such as the NFCPC, YD^{NFCPC} is entirely saved.

$SAVING^{HI}$ is used in the capital account (BB Table 6.1.7) for the calculation of net lending and borrowing position (FS^{HI}), which is the identical to the changes in net acquisition of financial assets based on stock-flow consistency. It shows how gross saving is allocated. Investment grants are additional sources of financing (i.e. changes in liabilities and net worth), and hence add to gross saving. Capital tax, gross fixed capital formation and changes in inventories are uses of funds (i.e., changes in assets) and need to be netted out from gross savings. Other capital transfers[58] are a net item, so could be either a positive or negative figure and net acquisitions of non-produced, non-financial assets[59] are assumed to be zero. In addition to all the items listed in the capital account[60], the household sector is also subject to capital tax[61], which is estimated by (4.22).

$$\begin{aligned} \triangle TAX^{CAPITAL_{hi}} &= -802.32 - 0.53TAX_{-1}^{CAPITAL_{hi}} + 6.26HP_{-1}^{mean} \\ &\quad +446.70NFAS_{-1}^{h}/GDP_{-1} + 0.01\triangle GDP \end{aligned} \tag{4.22}$$

with CP^M and the latter is assumed to remain at 2.3 per cent of IPA_{-1}^{HI}.

[55]Social contributions are paid on a compulsory and voluntary basis from households. Both actual and imputed social contributions paid by employers are included in the compensation to employees in the national accounts. Hence it is reasonable to assume they grow in step with total compensation. They are around 20 per cent of gross income.

[56]It is assumed to be 15 per cent of YP^{HI}.

[57]Adjustment for changes in pension entitlements is not counted in the model.

[58]Other capital transfers refer to the redistribution of savings or wealth. For instance, transfers made to compensate for the impact of a natural disaster will be recorded in this category.

[59]It consists of assets that have not been produced within the production boundary, and that may be used in the production of goods and services. For instance, natural resources (e.g. land, mineral and energy reserves, non-cultivated biological resources such as virgin forest, water resources, radio spectrum and others), contracts, leases and licences as well as goodwill and marketing assets.

[60]These are mainly estimated using the fixed share method.

[61]Capital tax is a tax levied on assets owned or transferred.

Both house prices (HP^{mean}) and financial asset measures ($\frac{NFAS^h}{GDP}$) appear to have a positive relationship with the amount of capital taxes collected.

4.4.6. Housing

The housing market is crucial to our analysis of the financial crisis. There are two behavioural equations, which have a significant impact on the model simulations (see sec. 4.5 for simulation results).

As we have seen from the US analysis, mortgage lending secured on properties can leak into consumption through housing equity withdrawal. Therefore, the positive feedback cycle between house prices and mortgage lending played an essential role in the GFC. The UKSIMM uses the number of mortgages issued ($MORT^N$) as a measure of credit standards to study the economic impact of the credit cycle. The house price equation is given by (4.23). On the supply side, both housing stock (H^{stock}) and new houses built (HB^{ha}) have expected negative signs for their coefficients. On the demand side, the mortgages issued per thousand people, the number of incoming migrant workers and private sector salaries have positive effects on the UK house prices. A higher long-term interest rate or stamp duty will discourage people from purchasing, so have negative coefficients.

$$\begin{aligned}\triangle ln(HPI) = {} & 1.34 - 0.19ln(HPI_{-1}) + 0.09ln(MORT^N/POP_{-1}) \\ & + 0.33\triangle ln(EARN^{priv_{awe}}) - 0.06ln(HB^{ha}_{-1}) \\ & - 0.07\triangle ln(STAMP_{-1}) - 0.03LR_{-1} \\ & - 6.74\triangle ln(H^{stock}_{-1}) + 0.0003MIG^w_{-1}\end{aligned} \tag{4.23}$$

The number of mortgages issued is modelled using (4.24). A positive reinforcing effect once again appears in the UKSIMM, as real house price growth shows a strong positive correlation with $MORT^N$. This may be because of the collateral effects. Similarly, high population growth will also increase the demand for mortgages. Both the mortgage rate (R^{mort}) and the long-term interest rate influence the cost of housing finance so they both have negative coefficients. Moreover, a higher debt-to-income ratio of households will also limit the demand for mortgages.

$$MORT^N = -7159466.09 + 259.77POP^w_{-1} - 1715098.75DEBT^{HI_{lt}}_{-1}/YD^{HI}_{-1} - 41804.90LR_{-1} - 62051.44\triangle R^{mort} + 831740.21 * \triangle ln(\frac{HPI_{-1}}{CP^m_{-1}}) \quad (4.24)$$

The average mortgage advance grows with the house price index with a constant coefficient of 60 per cent in the simulation. Newly built houses remain constant at their 2017 level. Given the current 'greenbelt' policy[62], no rapid expansion in housing supply is foreseen.

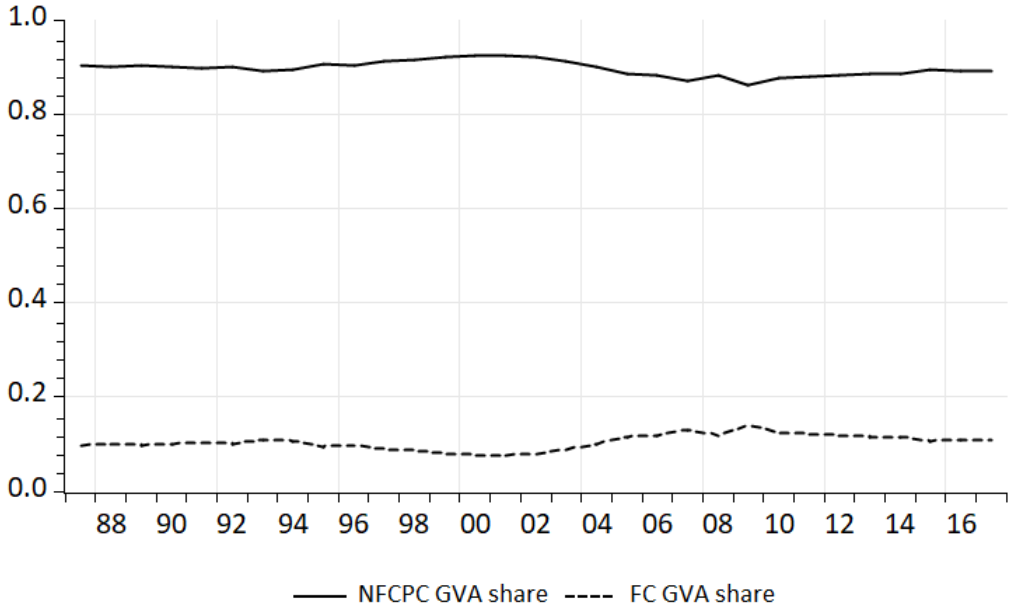
4.4.7. Corporate sector (COS)

Sales from the corporate sector as a whole should be equal to the GDP figure estimated using the expenditure approach. Taxes[63] and subsidies[64] on products relative to GDP have been fairly constant since 2011, hence we assume them to be 11.4 per cent and 0.5 per cent of the GDP respectively. GVA is calculated by netting out the GDP by taxes and subsidies on products.

As shown by Fig. 4.8, the GVA share for non-financial institutions (NFCPC) and financial institutions (FC) have also been quite steady over past decades, so they are projected using the same shares as in 2017.

[62]It is a planning policy that controls the urban expansion in the UK.
[63]Over half of the taxes on products in the UK are value-added taxes.
[64]Subsidies on products apply to every unit of goods and services that are produced and imported.

Figure 4.8.: The GVA shares for NFCPC and FC



Source: ONS and own calculation

Again we use the income approach to derive GOS^{cos} as a balancing item between GDP and all other incomes (BB Table 1.3B). These include the gross operative surplus of all the other sectors apart from NFCPC and FC, mixed incomes[65] , total compensation of employees[66] and taxes less subsidies on production and imports[67].

$COMP^{HI}$ is estimated using the annual wage bill from the private sector and the compensation to employees paid ($COMPH^{GG}$) from the government sector. The private sector annual wage bill is driven by two factors: the average private sector salary ($EARN^{priv_{avg}}$) and the total private sector labour force. The average wage equation is given below,

[65]Mixed incomes include incomes generated from unincorporated enterprises, such as small family-run firms and self-owned professional service providers. both labour incomes and capital incomes

[66]It is the compensation received by the household sector, $COMP^{HI}$ and the net compensation received from the external sector, $COMP^{W} - COMPH^{W}$

[67]They come from two sub-sectors of the corporate sector: NFCPC and FC and the household sector.

$$\begin{aligned}\triangle ln(EARN^{priv_{avg}}) &= 0.39 - 0.21ln(EARN_{-1}^{priv\_awe}) + 0.007W^t \\ &\quad +0.45ln(LFSE_{-1}/POP_{-1}) + 0.10ln(gos_{-1}^{cos}) \\ &\quad -0.90\frac{MIG^{cum}}{POPW_{-1}} + 0.03\triangle ln(ftse_{-1}) \end{aligned} \tag{4.25}$$

where W^t is a trend variable that reflects wage inflation over time. Average salary growth is positively correlated with the employment ratio in the entire population and the profitability of the corporate sector in the long-run. Strong stock market performance also has a positive impact in the short-run. The cumulative number of migrant workers within the working age population, however, has a deflationary effect as expected.

4.4.8. Non-financial corporations (NFCPC)

The GVA of the NFCPC is the sum of the compensation of employees ($COMPH^{NFCPC}$), taxes less subsidies on production other than products ($IT^{PDTN_{NFCPC}} - SUB^{PDTN_{NFCPC}}$) and the gross operating surplus (see BB Table 3.1.2). $COMPH^{NFCPC}$ has been around 1.17 times the wage bill[68] for the past decade, and the UKSIMM fixes it at the 2017 level for the baseline simulation. The sectoral wage bill in turn follows the dynamics of the NFC sector employment[69] and average annual salaries[70], an coefficient λ^{EARN} is assigned as well so it captures the unexplained share of the sectoral wage bill (see 4.26).

$$EARN^{NFCPC} = \lambda^{EARN} EARN^{Annual} LFSE^{NFCPC} \tag{4.26}$$

Similarly, the gross operating surplus (GOS^{NFCPC}) is assumed to be 59 per cent of the $COMPH^{NFCPC}$and $IT^{PDTN_{NFCPC}} - SUB^{PDTN_{NFCPC}}$ remains its 2017 share of the GVA over the simulation period.

[68]Compensation of employees is the total remuneration payable by an employer to an employee in return for his/her work. In addition to wages and salaries (in cash and in kind), it also includes employers' social contributions.

[69]It employs 75 per cent of total private sector total employees, so it follows the dynamics of 4.19.

[70]It is driven by the equation of the average weekly salary.

The primary income is detailed in BB Table 3.1.3. The balance is the sum of $GOS^{NFCPC}$and the net property incomes received. The gross property incomes received and paid are 3.5 per cent and 4.2 per cent of the total financial assets and liabilities respectively.

Primary income is the sum of the gross operating surplus and net property incomes. The property income received is assumed to be 3.5 per cent of the total financial assets, while property income paid is assumed to be 4.2 per cent of the financial liabilities.

Gross disposable income is derived from primary income in the secondary distribution of income table (BB Table 3.1.4). In the national accounts, total resources must equal total uses. The total resources are mainly from net social contributions from employees (ECC^{NFCPC}). Total uses consist of taxes on incomes ($TTAX^{NFCPC}$) and social benefits paid (SBF^{NFCPC}). The residuals are accounted for by the net current transfers[71] in the UKSIMM and are assumed to be constant after 2017. Based on the observation of UK data (see Fig. 4.9), the other three sub-components ($\frac{ECC^{NFCPC}}{COMPH^{NFCPC}}$, $\frac{TTAX^{NFCPC}}{GOS^{NFCPC}}$, and $\frac{SBF^{NFCPC}}{YP^{NFCPC}}$) are largely stationary over time, hence we assign historical shares for them in the model.

The net lending position (FS^{NFCPC}), which contributes directly to the acquisition of financial assets in the balance sheet, is consistent with the data presented in the capital account (BB Table 3.1.7). It is equivalent to the net value of the first two blocks for each column in Tab. 4.3. The resources that are not consumed will be in the form of gross savings[72], ($SAVING^{NFCPC}$) and net capital transfers[73]. They are either used for investing in fixed assets ($\triangle K^{NFCPC}$) or financing inventory accumulation ($\triangle IN^{NFCPC}$) and net acquisition of non-produced non-financial assets ($\triangle LN^{GG}$).

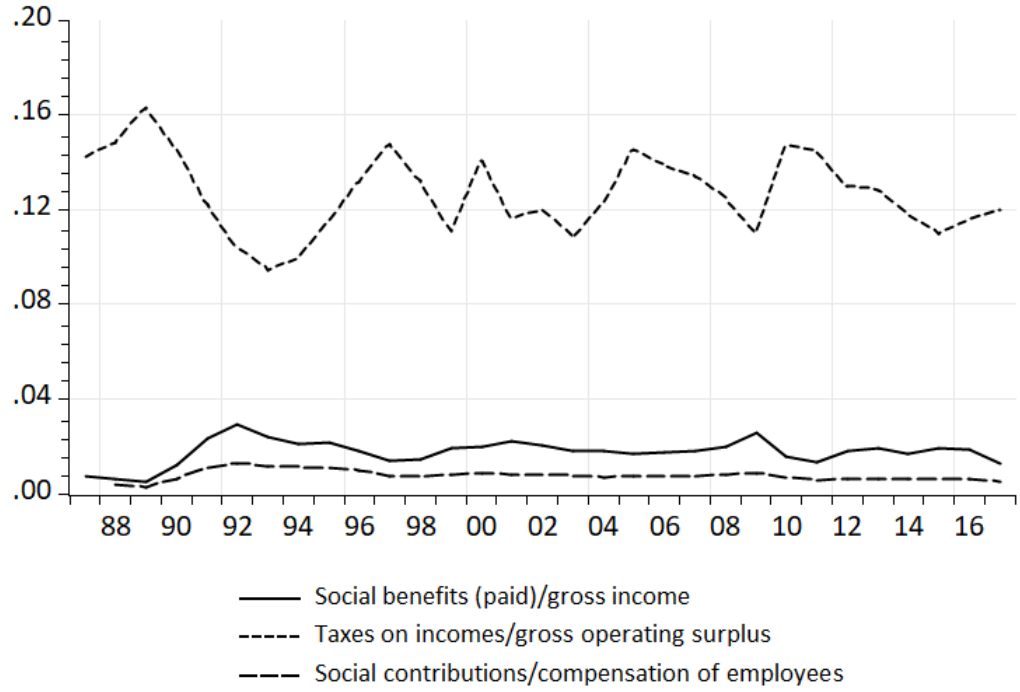
$kivl^{NFCPC}$ grows at an exogenous rate of 2 per cent, and the nominal value can be calculated using the GDP deflator. The value contributes to the value K in Tab. 4.2.

[71] Unlike capital transfers, current transfers have a direct impact on consumption and the level of disposable income.

[72] The capital depreciation is not modelled in the UKSIMM. It is equivalent to the gross disposable income in the model.

[73] There are three components of the capital transfer receivables: capital taxes from other sectors, investment grants and other transfers. The capital transfers payable only consist of two subcomponents: investment grants and other transfers. The sum of the net values from the corresponding sub-categories gives the net capital transfers in the capital account. It is assumed to take a negative value of 2 per cent of government consumption and investment. As a net value, this component has been highly volatile in the past and is therefore difficult to forecast.

Figure 4.9.: Shares of income taxes, net social contributions, and social benefits, 1987-2017



Source: ONS and own calculation

The gross capital formation at constant price contributes to the new acquisition of non-financial assets and also to the replenishment of depreciated fixed assets (8 per cent in the model).

Accumulation of inventories ($\triangle in^{NFCPC}$) , deflated by $GDPP$, is described by (4.27), it contributes to the IN term in Tab. 4.2.

$$\begin{aligned} \triangle^2 in^{NFCPC} &= 32361.62 - 0.61\triangle in_{-1}^{NFCPC} - 0.13 in_{-1}^{NFCPC} \\ &\quad -141480.86\triangle ln(CP^M) + 0.15\triangle gdp^{priv} \end{aligned} \tag{4.27}$$

$\triangle in^{NFCPC}$ is negatively related to the previous stock value in the long-run, which is sensible, given that high stock of inventories not only places a financial burden on business owners but also is a sign of an economic slowdown that signals to sellers

they need to adjust their expectations. Similarly, when the economy experiences high growth, reflected by $\triangle gdp^{priv}$ then businesses need to build up their inventories for the next period sales. It uses the GDP deflator.

4.4.9. Financial corporations (FC) and Banks (FC_MO)

Financial corporations

The same steps of deriving the net lending and borrowing positions described in previous subsections and Tab. 4.6 also apply to financial corporations. Also, given our intention is to simulate the interaction between the banking sector, a sub-sector of the FC, and the real economy, the UKSIMM has dedicated most of its behavioural relationships to the banking sector. The equations will be listed in the Appendix. There is only one behavioural equation that is specific to the FC sector - the gross fixed capital formation equation given by (4.28),

$$\begin{aligned} \triangle ln(\triangle k^{FC}) &= 5.76 - 0.57 ln(\triangle k^{FC}_{-1}) - 0.499 ln(kivl^{FC}_{-1}/gva^{FC}_{-1}) \\ &\quad +0.097 LR_{-1} - 0.04 TAX^{CT_{bank}}_{-1} + 6.62 \triangle ln(gdp) \end{aligned} \tag{4.28}$$

where $\triangle k^{FC}$ is positively correlated with real GDP in the short-run. In the long-run, the share of non-financial assets at constant price over GVA ($kivl^{FC}_{-1}/gva^{FC}$) has a significant negative impact on investment growth. This might be due to diminishing returns from additional investment. Unsurprisingly, a higher bank corporation tax rate[74] ($TAX^{CT_{bank}}$) will also limit investment, considering the banking sector accounts for a significant share of the FC. The sign for the long-term interest rate (LR) can either be positive or negative depending on whether the lending rate effects[75] outweigh the effects from borrowing costs. The UK data shows a positive sign consistently across various periods.

As discussed in the sec. 4.5, a significant limitation that can be improved in future is to further disaggregate the FC sector so that the interactions between the banking

[74] Adjustment to the data is made after 2016 to reflect the implementation of the bank corporation tax surcharge. It is set at a rate of 8 per cent on profits over £25 million.

[75] A higher lending rate will increase the profits for the sector.

sector and non-banking financial institutions (NBFIs), where shadow banking resides, can be simulated. This is important as shadow banking plays a highly salient role in the endogenous credit creation story.

Banks

The banking sector is a sub-sector of financial corporations. We again start by describing the key national accounting identities that are presented in the BB 2018. They are essentially a more comprehensive version of the transaction flows described in the top two blocks of the banking sector column in Tab. 4.3. The primary distribution of income account for the banking sector (BB Table 4.2.2) lists the GVA using the income approach. It contains the compensation of employees ($COMPH^{FC_{mo}}$), taxes less subsidies on production other than products ($IT^{PDTN^{FC_{mo}}} - SUB^{PDTN^{FC_{mo}}}$)[76], and the gross operating surplus ($GOS^{FC_{mo}}$).

$COMPH^{FC_{mo}}$ is estimated using a similar approach as in the NFCPC sector. It is 1.25 times the annual wage bill. The wage bill of the banking sector is in turn driven by the average private sector wage and the total number of banking professionals in the economy. The salary of an average banking professional is significantly larger than that of the average private sector worker in the UK, which is consistent with the empirical observation[77]. Banking professionals are assumed to comprise 1.96 per cent of total private sector employees[78].

$GOS^{FC_{mo}}$ is estimated based on the profitability of the banking sector. Considering the sector profits from the interest rate spreads, the UKSIMM calculates the gross operating surplus by applying the long-term interest rate (LR) to the banking sector financial assets $FAS^{FC_{mo}}$ and short-term rate (BR) to its financial liabilities ($FLS^{FC_{mo}}$). An additional behavioural equation for bad debts ($DEBT^{bad}$), is assigned to the gross primary incomes of the banking sector, as it has to be written off from the books and contributes negatively to the sector's incomes. In (4.29), the level of bad debts negatively correlates with GDP in both levels and in changes. Without major shifts in lending practices, it is unlikely to witness bad debts accumulate during economic booms. Similarly, the negative relationship between the

[76] It is around 2.5 per cent of the banking sector's GVA. It is relevant to note that there are no subsidies applied to the banking sector's production.

[77] The average salary in the UK financial industry exceeds 50k per annum, while the average private sector salary is about half that amount.

[78] The 2018 Labour Force Survey shows that business, research and administrative professionals account for 2.4 per cent of the total UK labour force so the share for banking professionals is adjusted accordingly.

short-term rate and the level of bad debts also appears to be statistical significant in the short run and long run. As the basis for other yield curve rates in the market, a lower short-term rate leads to lower lending rate, which ultimately affects borrowers' ability to service the existing debt stocks.

$$\begin{aligned}\Delta ln(DEBT^{bad}) = 60.14 &- 0.54 ln(DEBT^{bad}_{-1}) - 3.67 ln(gdp_{-1}) \\ &- 0.26 SR_{-1} - 28.00 \Delta ln(gdp) \\ &- 0.24 \triangle SR \end{aligned} \tag{4.29}$$

As usual, the gross primary incomes (BB Table 4.2.3) are derived by adding net property incomes to the $GOS^{FC_{mo}}$. Fixed rates of 1.4 per cent and 1.5 per cent are assigned to the property incomes received and paid respectively. The secondary distribution of income account (BB Table 4.2.4) details how gross disposable income ($YD^{FC_{mo}}$) is derived. Total resources must be matched by total uses in the account, so we have

$$YD^{FC_{mo}} = YP^{FC_{mo}} + OCTB^{FC_{mo}} - TTAX^{FC_{mo}} \tag{4.30}$$

where $OCTB^{FC_{mo}}$is the net current transfers[79] and $TTAX^{FC_{mo}}$ is the current taxes on income and wealth, which is estimated by applying an adjusted corporate tax rate ($\delta TAX^{CT_{bank}}_{-1}/100$) to its tax base measured by $GOS^{FC_{mo}}$. Social contributions and social benefits exactly cancel out each other in the banking sector, hence are not included. As shown in BB Table 4.2.6, $YD^{FC_{mo}}$ is equal to the gross savings $SAVINGS^{FC_{mo}}$.

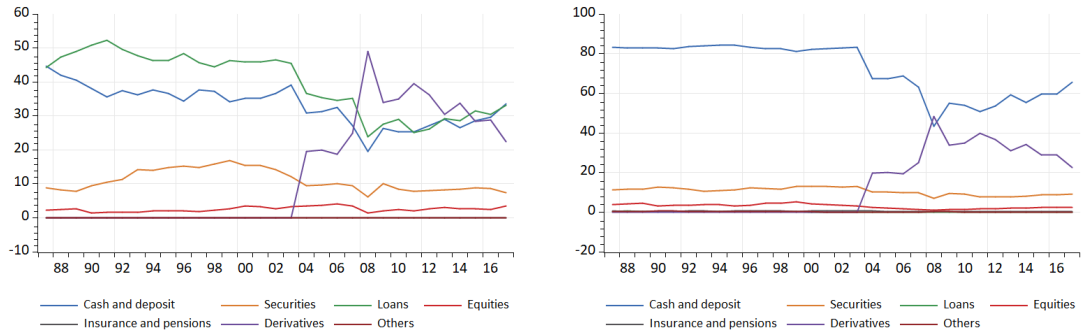
The net lending/borrowing position of the banking sector ($FS^{FC_{mo}}$) can be derived using the same steps described in Tab. 4.6 and then linked to the banking sector balance sheet. There are literally no changes in assets due to the changes in inventories, net acquisitions of valuables and net acquisitions of non-produced and non-financial assets in the banking sector, so all three items are zero in the model. Net capital

[79]Net current transfers consist of net non-life insurance premiums, non-life insurance claims and miscellaneous current transfers in the national account for the financial corporations. It remains constant in the model baseline.

transfers are assumed to be constant and $K^{FC_{mo}}$ is about 10 per cent of the sectoral GVA every year.

As observed in Fig. 4.10, financial asset and liability positions in the banking sector have undergone structural shifts after the early 2000s. In particular, there has been a surge in the importance of derivative holdings both on the asset and liability sides. Such a change in the nature of banking makes modelling very challenging. Considering our research focus is the traditional loan assets of the banking sector, 2017 shares are again used as the baseline scenario for our simulations.

Figure 4.10.: The Shares of Financial Assets and Liabilities, Banks



Source: ONS and own calculation

The growth of total financial assets in the banking sector (credit growth) is driven by nominal GDP, given the strong positive correlation between the two. A high mortgage scenario variable $MORT^{add}$ is also added to both the loan assets and total assets (see Tab. 4.7). This is consistent with the EM creation hypothesis, given the banking sector is the originator of mortgage loans in the economy. Their credit supply decisions are currently exogenous in the model. For a more realistic picture, they can be endogenised[80].

On the balance sheet, to ensure the mortgage loans added to the total financial assets are solely attributed to the loan assets, we have to use $FAS^{FC_{mo}} - MORT^{add}$ as the base for the high mortgage scenario simulations. Mortgage lending to the household sector ($MORT^{HI}$) comprises 33 per cent of the total loan assets of the banking sector. In the high mortgage scenario, although the loan assets as a whole remain at 33.24 per cent of the total assets, the mortgage lending share within the

[80]See sec. 4.5 for more discussion of this issue.

loan assets increases over time. The equation is given by

$$MORT^{HI} = 0.33LA^{FC_{mo}} + MORT^{add} \tag{4.31}$$

Mortgage lending on the asset side is matched by cash and deposits ($M4L^{FC_{mo}}$) on the liability side. The deposits are transferred to either the bank accounts of house sellers or the accounts of real estate companies soon after the transaction takes place. In the high mortgage scenario, the shares of $M4L^{FC_{mo}}$ will rise relative to the total. The relative shares of the other financial liabilities must fall accordingly to accommodate this change.

Table 4.7.: Financial balance sheet for the banking sector

Financial instrument	**Asset**	**Liability**
Money	$0.335(FAS^{FC_{mo}} - MORT^{add})$	$-0.66(FLS^{FC_{mo}} + MORT^{add}) + MORT^{add}$
Securities	$0.0736(FAS^{FC_{mo}} - MORT^{add})$	$-0.09(FLS^{FC_{mo}} + MORT^{add})$
Loans	$0.3324(FAS^{FC_{mo}} - MORT^{add})$	$-0.0003(FLS^{FC_{mo}} + MORT^{add})$
Equities	$0.036(FAS^{FC_{mo}} - MORT^{add})$	$-0.0229(FLS^{FC_{mo}} + MORT^{add})$
Insurance and pension	$0.0001(FAS^{FC_{mo}} - MORT^{add})$	$-0.2254(FLS^{FC_{mo}} + MORT^{add})$
Derivatives	$0.22(FAS^{FC_{mo}} - MORT^{add})$	$-0.004(FLS^{FC_{mo}} + MORT^{add})$
Others	$0.0002(FAS^{FC_{mo}} - MORT^{add})$	$-0.0001(FLS^{FC_{mo}} + MORT^{add})$

4.4.10. Government and central bank

The central bank, as the monetary policy authority, has a high level of autonomy. Both the policy rate and the amount of reserves are under its direct control. These two variables are set to be exogenous policy variables in the UKSIMM. Both can be used to generate scenario analyses. Therefore the current behavioural equations for the central bank are limited to the balance sheet only.

This section focuses more on the behavioural equations for the government sector. The nominal GVA of the government sector is estimated to be the sum of 50 per cent of nominal government consumption expenditure ($0.5C^{GG}$) and gross fixed capital formation ($\triangle K^{GG}$). This gives the total resources of the government sector.

In the primary distribution of income account (BB Table 5.1.2), the total resources of the government must be equal to the total uses. Total uses consist of gross operating surplus (GOS^{GG}), compensation of employees ($COMPH^{GG}$) and the

tax less subsidies expenditure on production other than products[81] ($IT^{PDT_{GG}} - SUB^{PDT_{GG}}$). Public sector compensations is a product of the total size of the public sector labour force ($LFSE^{GG}$) and the average salary. The average public sector salary is assumed to be slightly below the private sector level, which is given by, $0.9(COMPH^{NFCPC}/LFSE^{NFCPC})$. Therefore, GOS^{GG} can be derived as a residual from the accounting identity.

The balance of gross primary incomes (YP^{GG}) is given by (4.32). It follows the accounting identity presented in BB Table 5.1.3. In addition to GOS^{GG}, we also need the difference between total taxes received on production and imports (IT^{GG}) and total subsidies paid by the government sector (SUB^{GG}). The resources and uses of property incomes are assumed to be proportional to the total financial assets (3.2 per cent) and liabilities (2.4 per cent) respectively.

$$YP^{GG} = GOS^{GG} + IT^{GG} - SUB^{GG} + 0.032FAS_{-1}^{GG} - 0.024FLS^{GG} \tag{4.32}$$

Gross disposable income for the general government is the net outcome of secondary distribution of income (See BB Table 5.1.4). The total resources are the sum of gross primary income (YP^{GG}), tax revenues from the income and wealth ($TTAX^{GG}$) and net social contributions (ECC^{GG}). Total uses, on the other hand, consist of social benefits paid (SBF^{GG}) and other current taxes ($TAX^{GG_{paid}}$). The last term of the equation is the net amount of other current transfers. To limit the degree of complexity of the UKSIMM, $OCTB^{GG}$ is set at zero in the simulation.

$$YD^{GG} = YP^{GG} + (TTAX^{GG} - TAX^{GG_{paid}}) + (ECC^{GG} - SBF^{GG}) + OCTB^{GG} \tag{4.33}$$

$TTAX^{GG}$ is dependent on the the total taxes received from households and firms net of the net direct tax revenues paid to the external sector, while $TAX^{GG_{paid}}$is relatively small in size. As it has been held constant in the BB at £1.389 billion since 2012, the UKSIMM does likewise.

Social benefits paid at current prices, adjusted by CP^m, are estimated using the size of the retired and unemployed populations. A coefficient η, unit level of social

[81] There are neither taxes levied on government production nor subsidies given for government production. Both terms are zero across the simulation periods.

benefits, is assigned to the relevant population size. Social contributions received by the government sector include both compulsory social security contribution[82] (ECC^{NIC}) and pensions ($ECC^{GG_{pension}}$). Pension contributions account for 16.5 per cent of $COMPH^{GG}$ and ECC^{NIC} is estimated using (4.34).

$$\begin{aligned}\triangle ln(ECC^{NIC}) = &-1.57 - 0.19ln(ECC^{NIC}_{-1}) + 0.34ln(EARN^{priv}_{-1}) \\ &- 0.18ln(NIC^{uel}_{-1}) + 1.06\triangle ln(LFSE^{priv}) \\ &+ 0.03\triangle(NIC^{main}) \end{aligned} \tag{4.34}$$

ECC^{NIC} effectively works like an income tax. It is positively related to the 'tax' base, i.e., private sector income level ($EARN^{priv}$) and the total labour force ($LFSE^{priv}$). It is also affected by the 'tax' rate for each income band. As in 4.34, a higher standard tax rate (NIC^{main}) will increase the total contributions received, while the upper earning limit (NIC^{uel}) seems to have the opposite effect.

The government net lending/borrowing position (FS^{GG}) is derived from the BB Table 5.1.7 following the same steps as in Tab. 4.6. FS^{GG} is the net between total savings, which includes gross savings[83] and net capital transfers and total investment which consists of gross capital formation and the net acquisition of non-produced non-financial assets ($\triangle LN^{GG}$). The values of the other items are negligible and hence are not modelled.

The gross fixed capital formation at constant price assumes to grow at a constant rate of 3 per cent annually and the investment price deflator is the same as the GDP deflator. There are no changes in inventories for the government sector in the simulation.

[82] Social security contributions are compulsory payments paid to the general government that confer an entitlement to receive a (contingent) future social benefit. They include: unemployment insurance benefits and supplements, injury and sickness benefits, old-age pensions, disability and survivors' pensions, family allowances, reimbursement for medical and hospital expenses or provision of hospital or medical services. Contributions may be levied on both employees and employers.

[83] It is the difference between the gross disposable income and the final consumption expenditure of the government sector.

4.4.11. External

Given the primary focus of the UKSIMM is on the domestic credit creation process and its macroeconomic impacts, the modelling practice of the external sector is significantly simplified. The current account balance consists of the external account of goods and services (BB Table 7.1.0), the primary incomes, and current transfers (BB Table 7.1.2), which is given by (4.35).

$$\begin{aligned} CAB &= (X - M) + NCOMP^W + (IT^W - SUB^W) \\ &\quad + (PIC^W - PID^W) + TTAX^W \\ &\quad + (OCTC^W - OCTD^W) + SBF^W \end{aligned} \tag{4.35}$$

$X - M$ is the balance of goods and services, $NCOMP^W$is the net compensation of employees, $IT^W - SUB^W$is the tax on production net of subsidies paid, $PIC^W - PID^W$ gives the net property incomes received, tax on income, social benefits and net other current transfers are given by $TTAX^W$, SBF^W, and $OCTC^W - OCTD^W$ respectively.

The net lending position is the sum of the current account balance and the capital account (BB Table 7.1.7), which includes net capital transfers (OKT^W) and the net acquisition of non-produced non-financial assets ($\triangle LN^W$). The goods and services balance is the main behavioural driver of the current account and net lending positions. The volume and price equations for exports and imports are described in sec. 4.4.2 and sec. 4.4.3.

Most of the other sub-components in the current account and capital account are growing in line with nominal GDP, using the fixed shares calculated by BB 2017 data. PIC^W and PID^W are calculated based on the previous period stock of total financial assets and liabilities. $\triangle LN^W$ is assumed to be zero. Therefore, the position of the external balance is entirely driven by domestic dynamics.

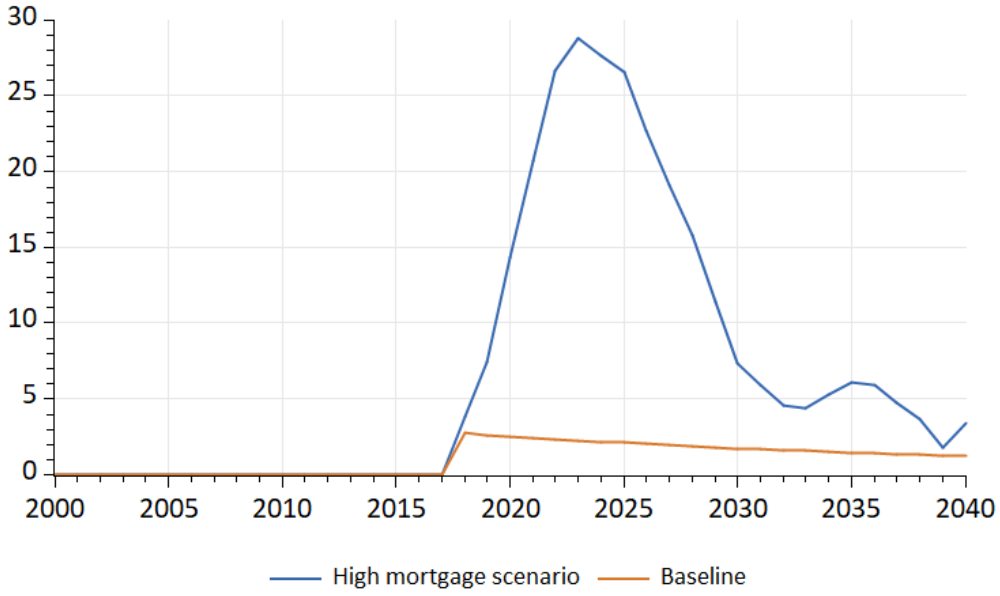
4.5. Simulation and future development

Simulation

The UKSIMM allows us to explore different economic scenarios by introducing shocks into the system with different scenario variables. Given our primary interest is to understand the interactions between housing finance, the credit cycle and the real economy, we constructed a high mortgage scenario to compare with the baseline results. As explained in the modelling section, a scenario variable, $MORT^{add}$, has been added to the balance sheets of three sectors in the economy. These are the banking sector, the NFCPC sector and the household sector.

In the baseline, the variable is constant throughout the simulation periods between 2018 and 2040. Since the total loan liabilities of the banking sector increases over time, so the share of $MORT^{add}$ inevitably decreases. In the alternative scenario, we have engineered a significant credit boom (high mortgage) which reaches more than 25 per cent of the loan liabilities in the banking sector at its peak. This is similar to the relaxation of credit standards observed in Fig. 3.8 before the GFC. This boom is then followed by a prolonged period of credit tightening. After the first super-cycle, the cyclical behaviour continues as suggested by Minsky's FIH, which enables us to quantitatively investigate the economic impact of such financial booms and busts.

Figure 4.11.: Share of additional mortgage lending in the total loan liabilities of the banking sector, baseline versus scenario



The balance sheet transactions are better illustrated with the help of Tab. 4.8. In

T_1, additional mortgage lending of £100,000, is issued to the household sector. The banking sector thus increases its loan assets by £100,000 and an equal amount of loan liabilities appears on the balance sheet of the household sector. As the mortgages are credited to the bank accounts of the borrowers as assets, the banks now also have an additional £100,000 as cash and deposit liability. The assets of both sectors match their liabilities. In T_2, as some of the households buy new residential buildings from real estate companies, 25 per cent of the deposits are now transferred to the companies' accounts in the NFCPC sector. If a borrower buys an existing property, such a transaction will end up in the account of another household. Therefore, £75,000 remain in the household sector. These shares remain exogenous in the simulation.

Table 4.8.: Financial balance sheet in the high mortgage scenario, 000s, £

	Banks		Non-financial corporations		Households	
	Asset	Liability	Asset	Liability	Asset	Liability
T_1	Loan £100	Deposit £100			Deposit £100	Loan £100
T_2	Loan £100	Deposit £100	Deposit £25		Deposit £75	Loan £100

Source: created by the author

Some simulation results are presented in Fig. 4.12 and Fig. 4.13. Fig. 4.12 shows the number of mortgage loans issued per thousand people in the UK. Since the 1970s the UK economy has been through various episodes of boom and bust. We have highlighted four major economic recessions and they seem to align closely to the mortgage loan cycle. Before the financial crisis, the number of mortgages issued remained above the historical average for nearly a decade.

In UKSIMM, mortgage lending is linked to the number of loans using (4.24). Without additional adjustments, the baseline scenario recovers very slowly. Although it increases continuously between 2020 and 2040, it is still below the historical mean level. The high mortgage scenario gives a more plausible picture, which presents similar cyclical patterns as observed in the historical data. It provides some justification for the feasibility of our assumption concerning the scenario variable, $MORT^{add}$. It should be noted that, our US analysis suggests that there is an indirect channel for the international capital flows to influence the domestic mortgage lending and house price. Kneer and Raabe (2019) also find evidence for the UK economy. Given the UKSIMM do not explicitly model the capital flows, the amplitudes of the simulated credit cycle are designed to be slightly lower than the previous cycles.

Figure 4.12.: Financial cycle, number of mortgage loans per thousand people

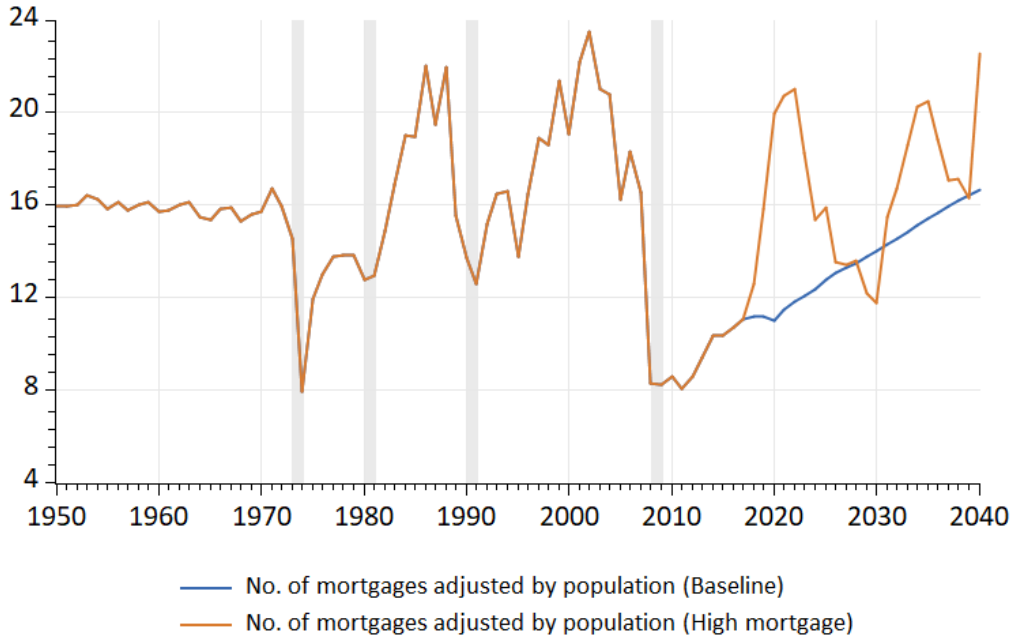


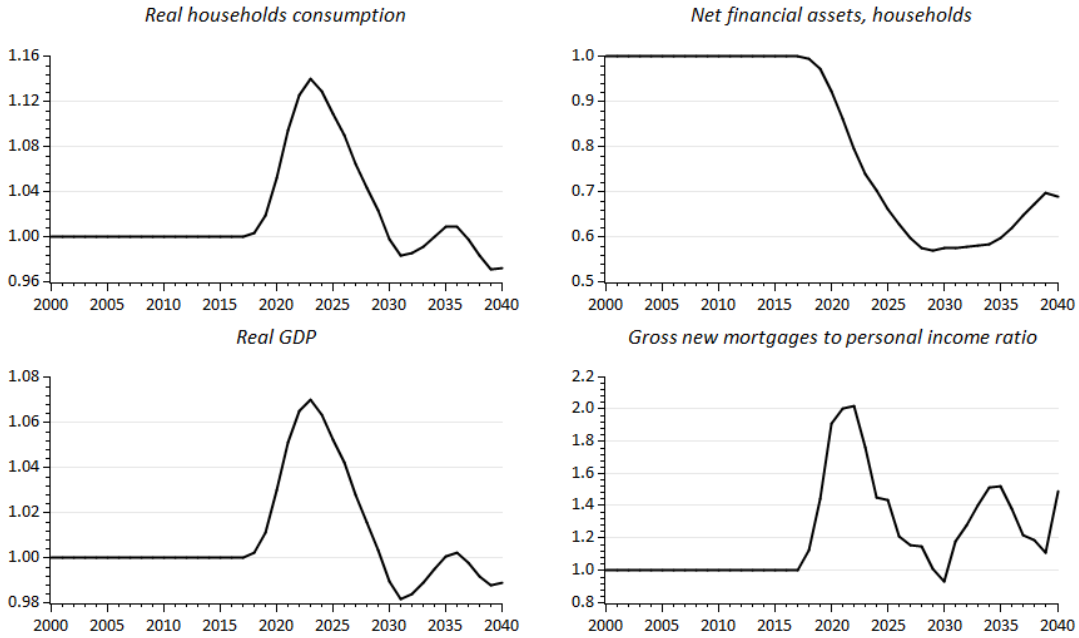
Fig. 4.13 compares the simulated results between the high mortgage scenario and the baseline, so the units are in percentage terms. The four variables of interest are real household consumption, household net financial assets, real GDP and household new debt to income ratio.

In Fig. 4.11, we notice that the share of mortgage lending constantly remains above the baseline level over the simulation period. A relaxation in lending standards would initially boost households and the overall economy compared with the baseline. However, when there is a tightening in credit standards, both real outputs and consumption will fall below the baseline level. The results appear to be consistent with the simulation in Section 11.8.2 of Godley and Lavoie (2007), which shows how a shift in the willingness to borrow can provide a stimulus to the economy in the short-term but will result in permanently lower levels of real output and consumption. The desire to borrow in the UKSIMM is estimated by the gross new mortgage to person income ratio, which is indeed much higher in the high mortgage scenario than the baseline on average.

The reverse effect might be the result of increasing debt service payments[84] and a worsening of the household net financial assets position. In Tab. 4.8, we have shown that some financial assets are transferred to NFCPC sector due to the purchase of new residential buildings, but that all mortgage liabilities will stay in the household sector. This reverse effect indeed took place in the UK and US, as GDP fell away from the historical trend after the GFC (see Fig. 5.1).

The simulation results supplement our findings from the US analysis. Given that the decline in trans-Atlantic capital flows only have short-run effects on real consumption and the trans-Pacific inflows continued to grow, there must be some other factors that have resulted in the permanent deviations of real consumption from its trend level. With the both the UK and US have kept their policy rate low after the GFC, the tightening in credit condition in the private sector seems to be the most important contributory factor.

Figure 4.13.: Impacts on the real economy, high mortgage versus baseline



The high mortgage simulation is not a purely hypothetical construct. The more realistic micro-level mechanism can be demonstrated using a set of sectoral balance

[84] Reinold (2011) argued that the declining in housing market transactions could be another suspect for the negative HEW observed in the UK after the GFC.

sheets and simulated using the UKSIMM accordingly. However, due to the time constraints on this PhD, we can only present the case set out by Lavoie (2019) as a guide for future work. Lavoie provided a more sophisticated version of Tab. 4.8 by incorporating interactions between non-bank financial institutions (NBFIs) and the non-financial sector (NFS). The presence of the NBFIs, also known as the shadow banking sector, is crucial in understanding the credit boom during the pre-crisis period.

Table 4.9.: Money creation through the shadow banking sector, 000s, £

	Bank		NBFI		Non-financial Sector	
	Asset	Liability	Asset	Liability	Asset	Liability
T_1	Loan £100	Deposit £100			Deposit £100	Loan £100
T_2	Loan £100	Deposit £80 CD £20	CD £20	MMF £20	Deposit £80 MMF £20	Loan £100
T_3	Loan £100	Deposit £95 CD £5	CD US£5 Security £15	MMF £20	Deposit £95 MMF £20	Loan £100 Security £15

Source: Lavoie (2019)

In T_1, an initial mortgage of £100,000 is originated by the banking sector to meet the demand from the household sector, a sub-sector of the NFS. The mortgage is, therefore, a financial asset for the banking sector and a liability for the NFS. The seller will receive the payment from the mortgage borrower and then deposit the same amount into the banking sector. In T_2, we assume some (£20,000) of the NFS deposits are invested in a Money Market Fund (MMF), as a result of the demand to diversify portfolio holdings. Consequently, the NFS holds two financial assets, deposits and an investment in a MMF, that are worth £100,000 in total. The banking sector is only partially liable to meet the withdrawal demand from the NFS (£80,000 at maximum), given the NBFI has now received a certificate of deposit of £20,000 from the NFS. In T_3, the NBFI invests £15,000 in company securities. A new source of credit is generated within the economy, given that the NFS holds a £100,000 mortgage and another £15,000 company securities as a liability. The increase in the liability of NFS is matched by an equal increase in deposit holdings. Therefore, the initial finance of £100,000 from the banking sector eventually resulted in an additional 15 per cent of credit entering the economy through the interactions between the NBFI and NFS.

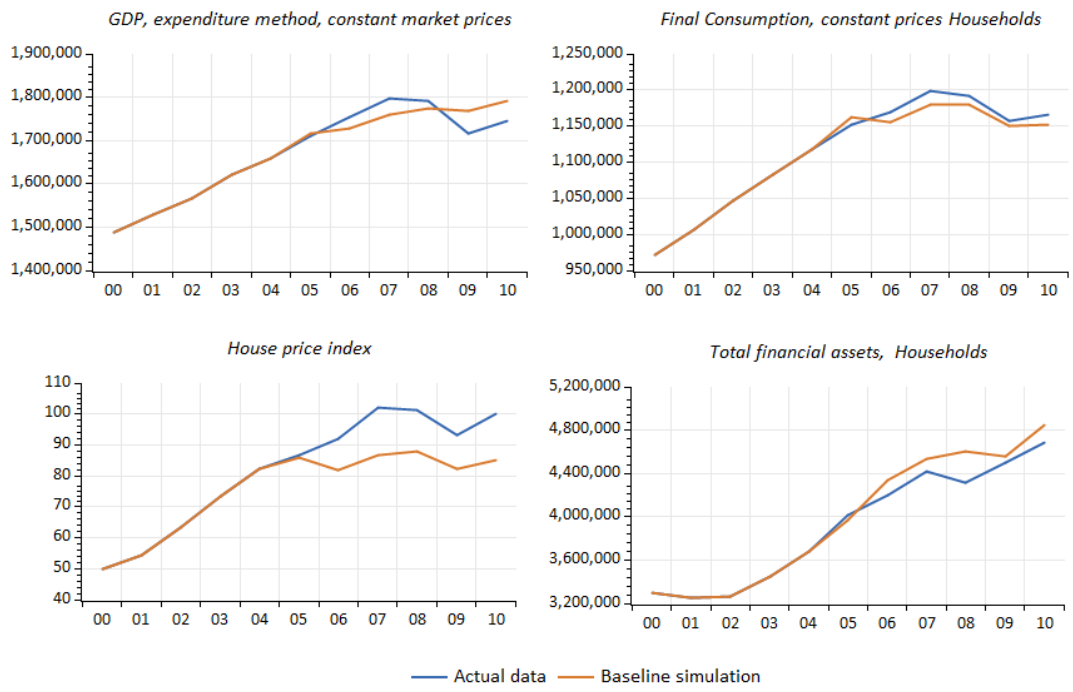
In a more general form, we assume that the initial financing amount is L, the percentage of the NFS assets engaged in an asset swap is α, and the portion of

additional credit created by the shadow banking sector is β. Both α and β range between 0 and 1, and β must not exceed the value of α. The total amount of credit in the economy is thus given by $(1+\beta)L$, with a maximum value of $2L$. The value of α and β reflect the investment preferences of the NFS and the NBFI respectively, which are likely to show a procyclical pattern aligned with the credit and asset boom and bust cycle.

Limitations and future development

The UKSIMM is only a prototype working model, and there is always room for improvement. Some of the behavioural equations are still ad-hoc in nature. Therefore, the realism of the UKSIMM is compromised to a certain degree. In order to examine the empirical validity in capturing the financial crisis, we conducted a within sample simulation between 2005 and 2010. Four key variables are selected and are shown in Fig. 4.14.

Figure 4.14.: In-sample simulation, selected variables



As expected, the results are mixed. The household sector has been the major focus of the UKSIMM at current stage, given its importance in the UK economy. The

in-sample forecasts for household consumption and total financial assets appears to reflect the actual data very well. However, the forecast performance for real GDP and house price index is less satisfactory. This is the result of the simplification of certain features, which will be subject to revision in future development. For example, real exports is assumed to grow at an exogenous rate of 2 per cent in the model. There are three features that would be highly valuable to add to the UKSIMM as the next step:

The first is to explicitly spell out the behavioural equations for the shadow banking sector. As presented by Lavoie (2019), the NBFI plays an essential role in the credit creation and securitisation process[85] in the modern economy. The lending activities between the NBFI and the real sector act as a multiplier of the initial finance that comes from the banking sector. Similarly, the NBFI can also help the banking sector to relax its liquidity and regulatory constraints through various ways, such as purchasing securitised financial products off the balance sheets of banks.

The second feature is to incorporate regulatory measures and examine the effectiveness of limiting credit creation from the domestic financial sector. This is closely related to the first feature. In Godley and Lavoie (2007), when the level of own funds of the banking sector is endogenised to the spread between lending and deposit rates. A low level of own fund requires a large enough spread to improve its position. Alternatively, the banks can either issue new shares or restrict dividends. All three methods require the acquiescence of capital markets to inject more capital when needed, otherwise public institutions have to step in as happened after the GFC. Lavoie (2019) argued that the higher capital adequacy ratio (CAR) requirement imposed by Basel III after the GFC may not be an effective measure to limit endogenous money creation. An example of the potential ineffectiveness of the measures occurred when UBS offered loans to purchasers of its newly issued shares to incentivise the purchase. Technically, this might be feasible but whether it is legal is subject to question, for example the Barclays-Qatar deal.

The third feature is to allow more realism in the dynamics of the external sector by building a multi-country SFC model. In the UKSIMM, the balance sheet of the external sector is only a residual item with no behavioural assumptions assigned. Both our US analysis in previous chapters and other empirical evidence from the

[85] Gorton and Metrick (2013) provided a detailed account of the securitisation process. Keys et al. (2012) argued that the increasing securitisation seem lower the lender's origination standards.

UK[86] lead us to believe that international capital flows are crucial in making sense of the lending dynamics within the UK economy. However, as the workload involved in building a multi-country empirical SFCM significantly exceeds the capacity of an individual researcher, a theoretical or semi-empirical approach must be considered. The four-country theoretical SFC model developed by Valdecantos and Zezza (2015) could serve as a baseline in this regard.

4.6. Conclusion

This essay firstly reviewed the development of pre-GFC macroeconomic models. Their failure in predicting the GFC is not a mere coincidence. Instead, there is a deep structural issue that plagued these models. In particular, a macroeconomic model that assigns no importance to the financial sector can be said to be like Hamlet without the 'Prince' (Borio, 2014). The financial sector is the missing piece of the puzzle that helps make sense of the GFC and the modern capitalist economy. Consequently, since the GFC much macroeconomic research seeks to bring back the 'Prince'.

Mainstream economists, such as Wren-Lewis (2018), do not think the GFC will result in a paradigm shift like those that followed the GD and GI in the 1930s and 1970s, as they still believe micro-founded macroeconomic models are fit for the future. To them what is needed are more realistic assumptions and behavioural modelling at the micro-level. However, the GFC has made economists more aware of the limits of mainstream models (e.g. the DSGE models), and to become more tolerant of other modelling strategies, such as structural econometric models and agent-based modelling.

Among all the alternative modelling strategies, the SFC approach has received the most rapid growth in interest from both academic researchers and policymakers across the globe. Advanced by Wynne Godley, one of the few economists to have foreseen the GFC, and his various co-authors, the SFC literature has expanded rapidly in the last decade. Instead of focusing on micro-foundations[87], the SFC approach is deeply rooted in national accounting and emphasises the completeness

[86] Kneer and Raabe (2019) found that foreign capital inflows positively correlated with the domestic credit boom, especially in the construction sector, during the pre-crisis period.

[87] In sec. 4.3, we have mentioned that there is a group of researchers that are engaged in incorporating the ABM into the SFC framework to provide micro-level behaviours.

of the economic system through watertight accounting rules. The words of Godley best describe this principle - 'everything must come from somewhere, and everything must go somewhere'. Along with the other econometric-based forecasting models, the SFCM provides greater external consistency with empirical data. It should be taken much more seriously or at least be accepted as part of the suite of macroeconomic models proposed by Blanchard (2018).

Our working empirical SFC model of the UK economy (UKSIMM) contributes to a burgeoning strand of literature on empirical SFCM. Compared with the other (only) three empirical UK SFC models, it has two distinctive features. Firstly, it added an active financial sector, in particular the banking sector, which allows us to study the interactions between the financial sector and the real economy. This is precisely what is missing from the pre-GFC literature. Secondly, the UKSIMM empirically estimates the full national accounts. Therefore, to the best of our knowledge, this is the first empirical SFCM for the UK at this scale. A simple case of the high mortgage scenario, which features a Minsky type credit cycle, has already captured many features observed before and after the 2007-09 financial crisis.

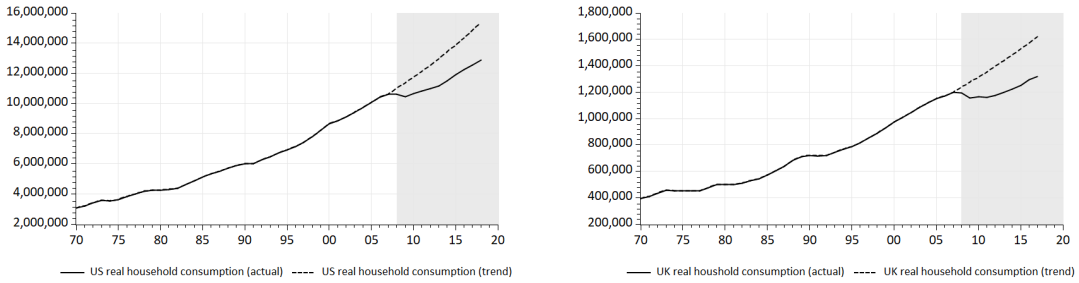
It complements very well with our inquiry into the underlying causes of the GFC in the previous chapters. Firstly, in the US analysis, foreign holding of corporate bonds only appear to have short-run effects on real consumption. As the surplus (GSG) countries continued their purchase of the US Treasury bonds after the crisis and the US policy rate was almost lowered to its zero-lower bound, the credit cycle contraction thus seems to be the most significant contributory factor in causing the permanent decline in real consumption in the US and UK.

That said, this work is nowhere near complete and will be the subject of more development in the future. This is merely the beginning of a long journey in SFC research. As mentioned in the last section, the accounting structure, especially the financial and external sector, is not yet complete and there are many other realistic features/behavioural equations that should be appended to the model.

5. Conclusion

The GFC led to the worst global recession since the Great Depression in the 1930s. As shown in Fig. 5.1, real household consumption in the US and UK, as a measure of welfare, has dropped permanently away from the historical trend after 2008. A decade later, there is still no sign of convergence back to the previous trend. Lower consumption levels have translated either into lower real incomes or, in some countries, into mass unemployment. Behind these numbers lies the suffering of millions of ordinary people. It is the responsibility of our generation to unravel the mysteries of the GFC and to provide a sensible solution to prevent or, at the very least, mitigate the impact of such calamities in future decades. The primary purpose of this thesis has been to inquire into the underlying causes of the 2007- 2009 GFC and its linkages with the current episode of global imbalances. Three independent yet interconnected essays have been developed to support this investigation. Each essay has analysed the GFC from a different perspective.

Figure 5.1.: Real household consumption in the US (left) and UK (right) after the GFC, millions, domestic currency



The first essay is a theoretical paper that sets the scene for the rest of the thesis. It contributes to the theoretical debates on the financial crisis by providing a critical review of the most up-to-date literature, especially on the GSG hypothesis. The GSG story emphasises the role of global current account imbalances in causing the

GFC (see sec. 2.3.2). Our assessment reveals that the conclusion of the GSG hypothesis relies on the classical theory of interest with interest rates acting as the equilibrating price that brings supply and demand of loanable funds into market equilibrium. The hypothesis argues that excessive savings in global markets that ended up flowing into the US economy were accountable for the decline of the US long-term interest rate. These excessive savings from surplus countries either directly fuelled the US domestic credit and housing boom or indirectly contributed to the boom through the channel of the long-term interest rate. The consequent consumption boom further worsened the US current account position and a vicious cycle developed leading to the financial meltdown of 2008. Advocates of the GSG hypothesis thus argue that the leading cause of the GFC was external to the US economy.

Theoretically, a persistent current account deficit can indeed pose a threat to economic stability. However, our review of various historic episodes of global imbalances (see sec. 2.3.3) suggests such a linkage between global imbalances and financial crises, as advocated by GSG proponents, cannot be justified. For example, the imbalances between the Roman Empire and the East persisted for centuries and the trans-Atlantic imbalances between the US and Europe in the late 19th Century adjusted smoothly through the price-specie flow mechanism. Therefore, there must be something unique to the current episode of the global imbalances that led to such a different result. Our review of two alternative hypotheses, the GFG and EM hypotheses, resolves this puzzle by highlighting two major theoretical weakness of the GSG hypothesis.

The GFG hypothesis argues that the current account position is inadequate as it only captures net capital flows, not gross capital flows, and that these gross flows are crucial in making sense of the GFC (see sec. 2.4.2). While in the 19th century, when capital flowed predominantly from Europe to the Americas to finance the development of the New World, the current account might have been a suitable measure (as net flows remained close to gross flows), with the rapid growth of two-way capital flows across the Atlantic over the past few decades it has become clear, if both gross inflows and outflows are large scale, then the current account alone cannot suitably capture such a development. Indeed this was clearly the case between Europe and the US in the years leading up to the GFC, when BIS estimated gross inflows from advanced European economies amounted to US$0.7 trillion but the current account as a whole remained broadly in balance. Unlike the trans-Pacific capital flows, which

consisted mainly of inflows from current account surplus countries used primarily for the purchase of US Treasury bonds and agency bonds, the majority of trans-Atlantic capital inflows went into the purchase of US corporate bonds, including the private-label MBSs that were at the epicentre of the financial crisis. Therefore, the clear implication is that the focus on current account imbalances alone was inadequate as it diverted attention away from a key development witnessed in the lead up to the GFC.

The EM hypothesis further highlights a weakness in the GSG hypothesis in that it fails to recognise the difference between saving and financing (sec. 2.4.1). The former is merely a national account concept showing what is left unconsumed, while the latter is a cash-flow concept that is critical in understanding the credit and housing boom before the GFC. The modern banking sector is capable of creating money/credit without acquiring savings in the first place. In fact, according to researchers at BoE and BIS (McLaren (2012); McLeay et al. (2014)), it should be the other way around, when a loan is issued, the same amount of deposits will be simultaneously credited to the borrower's account. Therefore, loans create savings and consequently there is no need for foreign savings to finance the housing and credit booms in the US. Thus, under this hypothesis, the relaxation in credit standards after decades of financial liberalisation and loose monetary policy in the US was the most significant contributory factor to the GFC.

However, although the first essay highlighted that the GSG hypothesis has significant theoretical flaws, it should not be entirely rejected without empirical support. Hence the second essay aimed to verify the claims made by the three competing hypotheses using US data. Four essential questions (see chapter 1) were formulated to guide our inquiry. For each question, a single equation ECM was constructed as the empirical strategy, which allowed us to study both the short-run and long-run effects.

Given the importance of household consumption in the US economy, the first ECM equation focuses on the determinants of household consumption. Our findings indicate that although neither mortgage lending nor housing wealth shows a robust positive correlation with household consumption, their interaction effects, reflected by the measure of HEW, appear to be highly significant and have a positive impact on household consumption. A negative HEW after the GFC was also witnessed in the UK. Despite its importance in explaining household consumption, research

on HEW remains surprisingly limited[1]. Its underlying mechanism deserves more investigation in future.

The second equation focuses on identifying the domestic determinants, suggested by the EM hypothesis, of the boom and bust cycles in the US housing and credit markets. We find that the rent-arbitrage model conforms very well with US house price data, but credit conditions only shows short-term effects. The mortgage liability model, however, identifies significant positive reinforcing effects with house prices as suggested by Ryan-Collins et al. (2017) and a strong positive correlation with credit standards in the long-run dynamics. Both house prices and the mortgage liability model therefore seem to support the claims of the EM hypothesis.

The third and fourth ECM equations investigate both direct (trans-Pacific capital flows) and indirect channels (long-term interest rate) as proposed by the GSG hypothesis. Measures for the trans-Atlantic capital flows are also included to examine the claims of the GFG hypothesis. The results identified no direct effect on house prices and mortgage liabilities from capital inflows measures. However, the GSG hypothesis makes a comeback through the long-term interest rate channel. The trans-Pacific capital flows appear to have long-run negative effects on the long-term interest rate, while the trans-Atlantic capital flows also exert downward pressure on the long-term interest rate, although the impact is short-lived.

The presence of two-way interactions among the four endogenous variables makes it extremely difficult to compare the relative importance of each factor. Therefore, a partial equilibrium model (USMOD) was constructed to fulfil this purpose. The USMOD is entirely consistent with the ECM findings, but it can now fully capture both direct and indirect effects after shocking the exogenous variables such as foreign capital flows.

The simulation results are very revealing. During the GFC, it was the fall in the foreign purchases of corporate bonds which hurt the US housing and credit market and consequently depressed household consumption. Foreign holdings of Treasury bonds continued to grow even during the post-crisis period and actually acted as a stabiliser for the US economy. Should the trend of foreign holdings of Treasury bonds have followed that of corporate bonds, the economic recession would have been much worse. However, given that the trans-Atlantic flows only have short-term effects on the long-term interest rate, this factor is unlikely to explain the

[1]Reinold (2011) is the only working paper on HEW at the BoE since 2000.

permanent deviation from the trend as seen in Fig. 5.1. Therefore, further inquiry into domestic factors such as credit standards and monetary policy is required. The stimulus effects are apparent when both measures are relaxed in the simulation.

In order to better model the domestic factors and their role in the GFC the third essay endeavoured to build an empirical SFC model with a banking sector for the UK. The essay commenced by providing a detailed discussion of the role of various macroeconomic models in understanding the GFC. The extensive literature review on the development of macroeconomic models led us to conclude that a macroeconomic model without an active financial sector is inadequate in analysing the modern monetary economy. Therefore, many mainstream macroeconomic models that do not have a financial sector significantly limit our ability to make sense of the GFC.

The growing interest in the SFC approach from both academia and policy institutions is a response to the failure of mainstream models in predicting and providing a satisfactory analytical framework for the GFC. We seconded the proposal of Blanchard that one should not expect a model to produce reliable answers for questions that are beyond the purposes the model was originally designed to address. Macroeconomic modellers must embrace more pluralism in the profession. Godley's success in predicting both the dot-com bubble and the GFC exemplify the usefulness of the SFC approach, which places great emphasis on the importance of accounting consistencies in dealing with the monetary and financial sides of the economy. The SFC approach thus undoubtedly deserves its legitimate place in the suite of economic models.

Our work in the third essay on the UKSIMM, a large-scale empirical SFCM, represents a major contribution to this field of inquiry. It essentially models the entire UK national accounts, so it provides a more complete picture of the economic dynamics than the USMOD. To the best of our knowledge, it is currently the only empirical SFCM for the UK economy at this scale. Compared with the other (only) three empirical UK SFC models, it has two distinctive features. Firstly, it adds an active financial sector, in particular the banking sector, to the CBR model which allows us to study the interactions between the financial sector and the real economy. Secondly, the UKSIMM empirically estimates the full national accounts, which provides a more comprehensive account than the BoE SFC model.

The simulation results from a Minsky-type financial cycle are complementary to

the USMOD results. The amplitudes of the simulated credit cycle are smaller than those in the early 2000s. This is reasonable as no international capital flows are incorporated into the UKSIMM and they do appear to indirectly affect the credit cycle in the USMOD. Moreover, the reverse effects during the downturn of the credit cycle resulted in a permanently lower level of household consumption which is consistent with the observation in Fig. 5.1. This in turn supplements the USMOD results. As a fall in trans-Atlantic capital flows only generates short-term effects, a permanent reduction in the levels of consumption and GDP in the US are likely to be the result of a tightening in credit standards.

As a working model, the model specification of the UKMOD will inevitably be subject to amendment in future research to further improve its realism[2]. In fact, the research to incorporate non-bank financial institutions has already started.

[2]For more discussion on future research please refer to sec. 4.5.

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A. Statistical test results

The following tables contain the unit root test results for the variables of interest presented in the long-run dynamics in Chapter 3. All the variables appear to be $I(1)$, that is, their first differences are stationary $I(0)$.

Table A.1.: Unit root test results for the household consumption equation

	Levels		**First difference**	
Variable	**ADF**	**PP**	**ADF**	**PP**
Housholds consumption, real	-1.243559	-1.243559	-6.963154***	-6.963471***
	(0.8896)	(0.8896)	(0.0000)	(0.0000)
Housing equity withdrawa, real	-1.463031	-0.191529	-2.712707***	-2.667808***
	(0.1318)	(0.6104)	(0.0081)	(0.0091)
Financial wealth, real	-1.379722	-1.348944	-6.227405***	-6.324271***
	(0.8544)	(0.8631)	(0.0000)	(0.0000)
Housing wealth, real	-3.176737	-1.785839	-3.851074**	-3.023223
	(0.1018)	(0.6957)	(0.0227)	(0.1372)
Mortgage liability, real	-2.282705	-2.029758	-4.060260**	-2.293266
	(0.4341)	(0.5705)	(0.0135)	(0.4292)
Consumer credit, real	-1.219520	-1.337206	-5.248433***	-5.169971***
	(0.8950)	(0.8663)	(0.0005)	(0.0006)
Disposable income, real	-1.243559	-1.243559	-6.963154***	-6.963471***
	(0.8896)	(0.8896)	(0.0000)	(0.0000)

Baseline model has a constant and trend is considered, P-values are in parenthesis
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively
[a]No costant or trend and pre-crisis sample

Table A.2.: Unit root test results for house price, mortgage liabilities, long term interest rate and foreign portfolio holdings

	Levels		First difference	
Variable	**ADF**	**PP**	**ADF**	**PP**
ln(Real house price)	-0.945667	-0.968399	-3.862548***	-2.768283*
	(0.7640)	(0.7572)	(0.0048)	(0.0706)
ln(Real user cost)	-2.334918	-1.720358	-5.031949***	-4.813633***
	(0.1544)	(0.4148)	(0.0001)	(0.0003)
ln(Real rent)	0.068021	0.507160	-3.913456***	-3.762526***
	(0.9598)	(0.9853)	(0.0040)	(0.0061)
ln(Real disposable income)	-1.530965	-1.535602	-6.599203***	-6.597439***
	(0.5096)	(0.5072)	(0.0000)	(0.0000)
Real mortgage debt liability[a]	-0.777861	-0.697269	-3.252952**	-2.348669
	(0.8157)	(0.8376)	(0.0233)	(0.1616)
Long-term interest rate[a]	-0.684503	-0.752155	-3.019101**	-5.796741***
	(0.8407)	(0.3060)	(0.0408)	(0.0000)
Effective mortgage rate[a]	-1.482332	-0.666866	-4.446826***	-3.985362***
	(0.5338)	(0.8452)	(0.0009)	(0.0032)
ANFCI credit condition[a]	-0.494415	-0.605361	-3.523847**	-2.781739*
	(0.8829)	(0.8597)	(0.0116)	(0.0686)
No. of mortgages[a]	-2.426799	-1.598988	-2.749107*	-2.749107*
	(0.1438)	(0.4703)	(0.0787)	(0.0787)
Short-term interest rate[a]	-2.213636	-1.466075	-5.206756***	-4.968755***
	(0.2043)	(0.5420)	(0.0001)	(0.0002)
ln(Treasury bonds), real	-0.403044	-0.861166	-3.779942***	-2.531601
	(0.8956)	(0.7869)	(0.0081)	(0.1184)
ln(Corporate bonds), real	-2.191210	-1.995010	-6.218585***	-5.946932***
	(0.2133)	(0.2874)	(0.0000)	(0.0000)
ln(Agency bonds), real	-1.802332	-2.492738	-3.510965***	-3.510965***
	(0.3722)	(0.1269)	(0.0146)	(0.0146)

Baseline model has a constant, P-values are in parenthesis, [a]not in log form
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively

Table A.3.: Endogeneity test for short-term variables in equations

Consumption model			
Equations	**Difference in J-statistic**	**Degree of freedom**	**Probability**
(1_1): 1970-2007	3.258658	3	0.3534
(1_2): 1970-2017	4.812736	3	0.1860
(2_1): 1970-2007	4.708352	3	0.1944
(2_2): 1970-2017	13.56151***	3	0.0036
House price model with international capital flows			
Equations	**Difference in J-statistic**	**Degree of freedom**	**Probability**
(1_1): 1971-2018	5.700188	3	0.1271
(1_2): 1986-2016	0.689036	3	0.8758
(1_3): 1986-2016	1.775220	3	0.6203
(4_1): 1986-2016	4.668329	4	0.3231
(4_2): 1986-2016	1.466724	4	0.8325
(4_3): 1986-2016	5.632968	4	0.2283
(5_1): 1993-2017	10.14480**	4	0.0381
(5_2): 1993-2017	5.094072	4	0.2778
(5_3): 1993-2017	4.679934	4	0.3217
Mortgage liability model			
Equations	**Difference in J-statistic**	**Degree of freedom**	**Probability**
(3_1): 1980-2007	3.047941	3	0.3843
(3_2): 1980-2013	3.425848	3	0.3305
(4_1): 1980-2007	3.899337	3	0.2725
(4_2): 1980-2018	10.61357**	3	0.0140
Long-term interest rate model			
Equations	**Difference in J-statistic**	**Degree of freedom**	**Probability**
(6): 1986-2016	10.62139*	5	0.0594
(7): 1986-2016	7.015038	5	0.2195
(8): 1986-2016	13.85934**	5	0.0165
(9): 1986-2016	12.90643**	5	0.0243

***, ** and * denote significance at the 1%, 5% and 10% levels, respectively

Table A.4.: Bounds test for selected equations

Consumption model					
				Bounds test[a]	
Equations	**Dependent variable**	**F-statistic**	**Degree of freedom**	**I(0)**	**I(1)**
(2_2): 1970-2017	Household consumption	4.63477[b]	(5, 36)	2.649	3.805
(2_2): 1970-2017	Disposable income	5.248293[b]	(5, 36)	2.649	3.805
(2_2): 1970-2017	Total financial assets	2.02003[c]	(5, 36)	2.649	3.805
(2_2): 1970-2017	Estimated HEW	4.335188[b]	(5, 36)	2.649	3.805
(2_2): 1970-2017	Consumer credit	1.567068[c]	(5, 36)	2.649	3.805
House price model with international capital flows					
				Bounds test[a]	
Equations	**Dependent variable**	**F-statistic**	**Degree of freedom**	**I(0)**	**I(1)**
(4_1): 1986-2006	Real house price	21.05937[b]	(5, 11)	2.649	3.805
(4_1): 1986-2006	Real user cost	2.524394[c]	(5, 11)	2.649	3.805
(4_1): 1986-2006	Real rent	1.658627[c]	(5, 11)	2.649	3.805
(4_1): 1986-2006	Non-agency MBS	5.678034[b]	(5, 11)	2.649	3.805
(4_1): 1986-2006	Net capital flows	1.567068[c]	(5, 11)	2.649	3.805
Mortgage liability model with international capital flows					
				Bounds test[a]	
Equations	**Dependent variable**	**F-statistic**	**Degree of freedom**	**I(0)**	**I(1)**
(4_2): 1986-2016	Real mortgage debt	50.87373[b]	(5, 21)	2.649	3.805
(4_2): 1986-2016	Real house price	14.5979[b]	(5, 21)	2.649	3.805
(4_2): 1986-2016	Real net financial wealth	6.515887[b]	(5, 21)	2.649	3.805
(4_2): 1986-2016	Credit standard: ANFCI	13.88162[b]	(5, 21)	2.649	3.805
(4_2): 1986-2016	Treasury bonds	8.755105[b]	(5, 21)	2.649	3.805
Long-term interest rate model					
				Bounds test[a]	
Equations	**Dependent variable**	**F-statistic**	**Degree of freedom**	**I(0)**	**I(1)**
(8): 1986-2016	Long-term interest rate	10.2992[b]	(4, 20)	2.850	4.049
(8): 1986-2016	Short-term interest rate	10.13679[b]	(4, 20)	2.850	4.049
(8): 1986-2016	Credit standard: ANFCI	0.58599[c]	(4, 19)	2.850	4.049
(8): 1986-2016	Corporate bonds	3.265853[d]	(4, 20)	2.85	4.049

[a]95% with intercept and no trend; [b]co-integration relationship confirmed;
[c]co-integration relationship rejected; [d]inconclusive

B. Notations and List of equations for UKSIMM

The list of notations contains all the major variables that have been used in the UKSIMM. Notations in the main text are slightly different from the Eviews model file. There are some general rules applied when converting the Eviews notations into the main text notations.

In Eviews, variable names that end with letter '**N**' and '**V**' represent the nominal and real values of the corresponding variables. For instance, **CN** stands for the nominal value of aggregate consumption and **CV** is the real value. In the main text, however, nominal values are in upper cases and real values are in lower cases. Therefore, **CN** and **CV** are converted into $\boldsymbol{C}$ and $\boldsymbol{c}$ respectively in Chapter 4.

In the main text, the superscript indicates the economic sector that the variable is associated with. For example, while **CV_HI** stands for the real value of household consumption in Eviews, it appears to be $\boldsymbol{c^{HI}}$ in Chapter 4.

While the subscript gives the time lag of the variable in the main text, the time lags are specified in brackets following the variables in Eviews. For example, the nominal value of aggregate consumption with one lag is given by **CN(-1)** in Eviews and $\boldsymbol{C_{-1}}$ in Chapter 4.

The list of equations specifies all the accounting identities and behavioural equations in the UKSIMM as appeared in the Eviews model file. The notation rules described above also apply.

The statistical significance of the coefficients in the behavioural equations are denoted by * sign. ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Adjusted R^2, as a measure of goodness-of-fit, and the data sample period are provided at the end of each behavioural equation.

If a behavioural equation or the accounting identity also appears in the main text as

a displayed formula, its associated equation number and page number in the main text will be presented as well.

Let us consider the equation for real household consumption (**Eq4**) in the **list of equations** as an example. Almost all of the coefficients in the equation are statistically significant at 1 per cent level, except the coefficient for mortgage rate. The adjusted R^2 suggests that the regression model can explain 95 percentage of the variations in real household consumption using UK data between 1975 and 2017. In the main text, the same equation is appeared to be equation (4.9) on page 181.

List of notations

Notations in Eviews	Description	Notations in Chapter 4
BAD_DEBTS	Amount of bad debts in banks	$DEBT^{bad}$
CBALN	Current account balance	CAB
CN	Aggregate consumption, nominal	C
COMPHN	Total compensation to employees, paid	$COMPH$
COMPN	Total compensation of employees	$COMP$
CP_GG	Consumption deflator for government sector	CP^{GG}
CUM_MIGW	Cumulative working age migration	MIG^{CUM}
CV	Aggregate consumption, real	c
DEBT_HI_LT	Household long-term debts	$DEBT^{HI_{LT}}$
DEBT_HI_ST	Household short-term debts	$DEBT^{HI_{ST}}$
DEBT_HI_OTH	Other debts held by households	$DEBT^{HI_{OTH}}$
DERA	Derivatives assets	$DERA$
DERL	Derivatives liabilities	$DERL$
DIN	Changes in inventories, nominal	ΔIN
DIV	Changes in inventories, real	Δin
DKIVP	Deflator for gross fixed capital formation	$IVP^{\Delta K}$
DKN	Total gross capital formation, nominal	ΔK
DKV	Total gross capital formation, real	Δk
DLN	Acquisitions less disposals of non-produced, non financial assets	ΔLN
DSA	Debt securities, assets	DSA
DSL	Debt securities, liabilities	DSL
DVN	Acquisitions less disposals of valuables, nominal	ΔV
DVV	Acquisitions less disposals of valuables, real	Δv
EARNINGS	Wages and salaries	$EARN$
EARNINGS_PRIV_AWE	Private sector average weekly salary	$EARN^{PRIV_{AWE}}$
ECCN	Total social contributions, nominal	ECC
ECCN_GG_PENSIONS	Social contributions, pension, government sector, nominal	$ECC^{GG_{pension}}$
ECCN_HI_PRIV	Total social contributions, private sector, nominal	$ECC^{HI_{priv}}$
ECCN_NIC	General government compulsory social contribution received	ECC^{NIC}
EFXI	Effective exchange rate index	$EFXI$
EMP_RATE	Employment rate	R^{EMP}
FASN	Total financial asset, nominal	FAS
FLSN	Total financial liability, nominal	FLS
FSN	Net lending and borrowing, nominal	FS
FTSE	FTSE all share index	$FTSE$
GDPN	Gross domestic product, nominal	GDP
GDPP	GDP deflator	$GDPP$
GDPV	Gross domestic product, real	gdp
GDPV_PRIV	Gross domestic product, private sector, real	gdp^{priv}
GOLDN	Gold reserves and SDR, nominal	$GOLD$

Notations in Eviews	**Description**	**Notations in Chapter 4**
GOSN	Gross operating surplus, nominal	GOS
GOSNMIX_HI	Gross operating surplus and mixed incomes, nominal, household sector	NA
GVAN	Gross value added, nominal	GVA
HB_HA	House building, housing association	HB^{ha}
HB_PR	New house building, private sector	NA
HMEANADV	Average mortgage advances	$HMEANADV$
HP_MEAN	Average house price	HP^{mean}
HPI	House price index	HPI
HSTOCK_PR	Total housing stock, private sector	$H^{stock_{priv}}$
INV_GRANTS	Investment grants	INV^{grants}
INVN_M	Stock of inventories, nominal	INV^{M}
INVV_M	Stock of inventories, real	inv^{M}
IPA	Insurance and pensions, assets	IPA
IPL	Insurance and pensions, liabilities	IPL
ITN_GG	Taxes on products and production, government sector	IT^{GG}
ITN_PDTN	Taxes on production other than products	IT^{PDTN}
ITN_PDTS	Total taxes on products (VAT and others)	IT^{PDTS}
KIVLN	Stock of non-financial assets, nominal	$KIVL$
KIVLV	Stock of non-financial assets, real	$kivl$
LA	Loan, assets	$IVP^{\Delta K}$
LA_FC_MO_LT_HI	Long-term loan assets held by banks against the household sector	NA
LFSE	Total labour force	$LFSE$
LFSE_PRIV	Total labour force, private sector	$LFSE^{priv}$
LFSE_PRIV_EE	Employees in private sector	$LFSE^{priv_{ee}}$
LFSE_SE	Self-employed in private sector	$LFSE^{se}$
LFSU	Unemployment	$LFSU$
LL	Loan, liabilities	LL
LR	Long-term interest rate	LR
LRA	Financial asset returns coefficient, household sector	NA
M4A	Cash and deposit, assets	$M4A$
M4L	Cash and deposit, liabilities	$M4L$
MIGW	Incoming migrant workers	MIG^{w}
MN	Imports, nominal	M
MORTGAGE_RATE	Mortgage rate	R^{mort}
MP	Imports deflator	MP
MV	Imports, real	m
NETDEBT_GG_ONS	Net government debt, stock	$NDEBT^{GG}$
NFASN	Net financial assets, nominal	$NFAS$
NIC_UEL	National insurance standard rate	NIC^{UEL}
NOTES_ISSUED	Bank notes	$NOTES$
OARA	Other financial assets	$OARA$
OARL	Other financial liabilities	$OARL$
OCTBN	Other current transfers, net	$OCTB$
OCTCN	Other current transfers, resource	$OCTC$
OCTDN	Other current transfers, uses	$OCTD$
OKTBN	Capital transfers, net	$OKTB$
OKTCN	Capital transfers, resources	$OKTC$
OKTDN	Capital transfers, uses	$OKTD$
OTH_CAP_TRANS	Other capital transfers	NA

Notations in Eviews	**Description**	**Notations in Chapter 4**
PENSION_FUNDS_HI	Pension funds, household	$PFUND^{HI}$
PICN	Property income received, nominal	PIC
PIDN	Property income paid, nominal	PID
POPN	Total population	POP
POPN65	Population above 65	POP^{65}
POPW	Working age population	POP^{w}
REPAY_RATE	Repayment rate	R^{repay}
RESERVES	Bank reserves	$Reserves$
SALESN	Total sales, nominal	S
SALESV	Total sales, real	s
SAVING	Gross savings	$SAVINGS$
SBFN	Net social benefits, nominal	SBF
STA	Stocks and equities, assets	STA
STAMP_DUTY	Stamp duty receipts	$STAMP$
STL	Stocks and equities, liabilities	STL
SUBN	Total Subsidies, nominal	SUB^{GG}
SUBN_PDTN	Subsidies on production	SUB^{PDT}
SUBN_PDTS	Subsidies on products	SUB^{PDTS}
TAX_CAPITAL_HI	Capital taxes paid by households	$TAX^{CAP_{HI}}$
TAXN_HI	Taxes on incomes and wealth and compulsory social contributions, household	TAX^{HI}
TTAXN	Taxes on incomes and wealth	$TTAX$
WAGE_TARGET	Wage target	$WAGE^{Target}$
XN	Exports, nominal	X
XP	Exports deflator	XP
XV	Exports, real	x
YDN	Gross disposable income, nominal	YD
YPN	Gross primary income, nominal	YP

List of equations

No.	Equation in UKSIMM	Description
Eq1	GDPV = CV_HI + CV_GG + DKV + DIV_M + DIV_GG + DVV_M + DVV_GG + XV - MV, Eq(4.8), p.181	Real GDP
Eq2	GDPN=GDPV*(GDPP/100)	Nominal GDP
Eq3	GDPV_PRIV=GDPV-GVAN_GG/(GDPP/100)	Private sector GDP, real
Eq4	D(CV_HI)=139196.73***-0.54***CV_HI(-1)+0.26***((YDN_HI(-1)))/(CP_M(-1)/100)+0.037***FASN_HI(-1)/(CP_M(-1)/100)+0.027***NUMLOANS(-1)(HMEANADV(-1)/100000)/(CP_M(-1)/100)+0.14***D(YDN_HI/(CP_M/100))+115803.61***DLOG(HPI/CP_M)-151887.04***REPAY_RATE(-1)+1.52***D(FASN_HI/CP_M)-1065.98*MORTGAGE_RATE(-1)-176404.72***DEBT_HI_ST(-1)/YDN_HI(-1)-22.68**D(DEBT_HI_ST/CP_M)+12.36***D(DEBT_HI_LT/CP_M)+16779.98***D90+11678.55**D2005, adj. R^2 = 0.95, sample:1975-2017, Eq(4.9), p.181	Real household consumption
Eq5	REPAY_RATE=0.08	Repayment rate
Eq6	CN_HI=CV_HI*(CP_M/100)	Nominal household consumption
Eq7	CP_GG=CP_M	Government consumption deflator
Eq8	CV_GG=CV_GG(-1)*1.02	Real government consumption
Eq9	CN_GG=CV_GG*(CP_GG/100)	Nominal government consumption
Eq10	DKV=DKV_HI+DKV_COS+DKV_GG, Eq(4.10), p.182	Gross fixed capital formation, real
Eq11	DKV_COS=DKV_NFCPC+DKV_FC	Gross fixed capital formation, real, corporate sector
Eq12	DKN_COS = DKN - DKN_HI - DKN_GG	
Eq13	DKN = GDPN + MN - (CN_HI + CN_GG + DIN_M + DIN_GG + DVN_M + DVN_GG + XN)	Gross fixed capital formation, nominal, households
Eq14	DKN_HI = 0.251957767DKN	
Eq15	DLOG(DKV_HIX) = 3.95***- 0.35***LOG(DKV_HI(- 1)) + 0.51***DLOG(HB_PR*HP_MEAN/YDN_HI) - 0.005*MORTGAGE_RATE(-1) + 0.17***D88 - 0.13***D97 - 0.09D2012, adj R^2 = 0.88, sample:1987-2017, Eq(4.11), p.183	Gross fixed capital formation, real, households
Eq16	DKV_HI=DKV_HIX+0.25*LA_FC_MO_LT_ADD/(GDPP/100)	Gross fixed capital formation, real, households, scenario
Eq17	D(DIV_MX) = 87.95-0.71***DIV_M(-1) + 0.18***D(GDPV_PRIV) - 2080.96***D(GDPP)-16747.42***D99 + 8735.54**D98, adj. R^2=0.82, sample: 1980-2017, Eq(4.12), p.183	Changes in inventories, real, total
Eq18	DIV_M=DIV_MX	Changes in inventories, real, total, adjustment
Eq19	INVV_M=INVV_M(-1)+DIV_M	Stock of inventories, real
Eq20	DIN_M=INVN_M-INVN_M(-1)	Changes in inventories, nominal
Eq21	INVN_M=INVN_M(-1)*(MP+GDPP)/(MP(-1)+GDPP(-1))+DIV_M*(GDPP/100)	Stock of inventories, nominal
Eq22	DIV_HI=0.0025*(GVAN_HI/(GDPP/100))	Changes of inventories, real, households
Eq23	DIN_HI=0.001*GVAN_HI	Changes of inventories, nominal, households
Eq24	XV=XV(-1)*1.02	Exports, real
Eq25	XN=XV*(XP/100)	Exports, nominal
Eq26	DLOG(MV) = -6.73***-0.71***LOG(MV(-1))+0.78***LOG(CV_HI(-1))+0.23***LOG(XV(-1))+0.09*LOG(CV_GG(-1))+0.07**LOG(DKV_COS(-1))+1.66***DLOG(GDPV-XV+MV)+0.46***DLOG(XV)-0.05***LOG(LFSU(-1)/POPW(-1))+0.05***D84+0.07***D74, adj. R^2 = 0.91, sample: 1970-2017, Eq(4.13), p.184	Imports, real
Eq27	MN=MV*(MP/100)	Imports, nominal
Eq28	GOSN=GOSN_HI+GOSN_NFCPC+GOSN_FC+GOSN_GG+GOSN_W	Total gross operating surplus
Eq29	DLOG(CP_M) = 0.58***- 0.32***LOG(CP_M(-1)) + 0.25***LOG(EARNINGS_PRIV_AWE(-1)) + 0.11***LOG(MP(-1)) - 0.27***LOG(GDPV_PRIV(-1)/LFSE_PRIV(-1)) + 0.12***DLOG(MP) + 0.10*DLOG(MINIMUM_WAGE(-1)) + 0.47***DLOG(EARNINGS_PRIV_AWE), adj. R^2 = 0.90, sample: 1982-2017, Eq(4.14), p.185	Consumption deflator
Eq30	DLOG(EFXI) = 0.34*-0.08**LOG(EFXI(-1))-0.01***(@PC(CP_M(-1))-@PC(USA_CPI(-1)))+0.008***D(WTI)+0.01***(XN(-1)-MN(-1))/GDPN(-1)*100 + 0.02**(LR(-1)-USA_LR(-1)), adj. R^2 = 0.35, sample:1970-2017, eq(4.18) p.187	Effective exchange rate
Eq31	MORTGAGE_RATE=LR+0.75	Mortgage rate
Eq32	DKIVP=DKN/DKV	Investment deflator
Eq33	GDPP = 1.03***GDPP(-1) + 0.63***CP_M - 0.64***CP_M(-1) + 0.24***XP - 0.24***XP(-1) - 0.19***MP + 0.18***MP(-1) + 0.12***BR - 0.497***, adj. R^2 = 0.99, sample: 1951-2017	GDP deflator

No.	Equation in UKSIMM	Description
Eq34	DLOG(MP)=1.59***-0.19***LOG(MP(-1))-0.19***LOG(EFXI(-1))+0.05***DLOG(WORLD_RMP(-1))+0.022***LOG(OILPR$PB(-1))+0.035***DLOG(OILPR$PB)-0.697***DLOG(EFXI)+0.25***DLOG(WTI)+0.08***D80-0.07***D86, adj. $R^2 = 0.92$, sample: 1979-2017, Eq(4.15), p.186	Import prices
Eq35	D(LR) = -0.979**-0.04**LR(-1)+0.17***D(BR)+0.22***D(USA_BR)+0.01***EFXI(-1)+2.62***D74-1.44***D98+1.81***D90-1.02**D2012, adj. $R^2 = 0.81$, sample: 1970-2017, Eq(4.17), p.187	Long-term interest rates
Eq36	LOG(XP) = 0.008 + 0.95***LOG(XP(-1)) - 0.14*LOG(XP(-2)) + 0.63***LOG(MP) - 0.44***LOG(MP(-1)), adj. $R^2 = 0.998$, sample:1970-2017, Eq(4.16), p.186	Export prices
Eq37	YPN_HI=GOSNMIX_HI+COMPN_HI+(LRA/100)*FASN_HI(-1)-(0.01+BR/100)*DEBT_HI(-1)	Gross primary incomes, households
Eq38	LRA=(((1+BR)*M4A_HI)+(4*LA_HI)+(4*STA_HI)+4*IPA_HI)/FASN_HI(-1)	Financial asset returns coefficient, households
Eq39	YDN_HI=YPN_HI+SBFN_GG+SBFN_HI_PRIV-TTAXN_HI-ECCN_GG-ECCN_HI_PRIV+OCTBN_HI	Gross disposable income, households
Eq40	SBFN_HI_PRIV=0.023*IPA_HI(-1)	Net social benefits, private sector
Eq41	ECCN_HI_PRIV=ECCN_HI_PRIV(-1)*(COMPN_HI/COMPN_HI(-1))	Net social contributions, private sector
Eq42	OCTCN_HI=OCTCN_HI(-1)*CP_M/CP_M(-1)*0.99	Current transfers, received
Eq43	OCTDN_HI=OCTDN_HI(-1)*CP_M/CP_M(-1)	Current transfers, paid
Eq44	OCTBN_HI=OCTCN_HI-OCTDN_HI	Net current transfers
Eq45	TAXN_HI=TTAXN_HI+ECCN_NIC	Taxes on incomes and wealth and compulsory social contributions, household
Eq46	TTAXN_HI=0.15*YPN_HI	Taxes on incomes and wealth
Eq47	ECCN_HI=0.2*YPN_HI	Social contribution, households
Eq48	SAVING_HI=YDN_HI-CN_HI	Gross saving, households
Eq49	D(TAX_CAPITAL_HI)=-802.32***-0.53***TAX_CAPITAL_HI(-1)+6.26***HP_MEAN(-1)+446.70***NFASN_HI(-1)/GDPN(-1)+0.009***D(GDPN)+598.93***D2013, adj. $R^2 = 0.71$, sample: 1987-2017, eq(4.22), p. 192	Capital tax paid, households
Eq50	INV_GRANTS_HI=0.00265*GDPN	Investment grants, households
Eq51	OTH_CAP_TRANS_HI=0.002*GDPN	Other capital transfers, payable, households
Eq52	FSN_HI = SAVING_HI + INV_GRANTS_HI - TAX_CAPITAL_HI + OTH_CAP_TRANS_HI - DKN_HI - DIN_HI - DLN_HI + BALANCE_HI	Net lending position, households
Eq53	FASN_HI = FASN_HI_EXCL + PENSION_FUNDS_HI + (0.75 * LA_FC_MO_LT_ADD)	Total financial assets, households
Eq54	DLOG(FASN_HI_EXCL)=0.13-0.63***LOG(FASN_HI_EXCL(-1))+0.57***LOG(EARNINGS_PRIV(-1))+0.18***LOG(FTSE(-1))+0.22***DLOG(FTSE)-0.09***D2001-0.14***D2002, adj. $R^2 = 0.73$, sample: 1988-2017, Eq(4.3), p.172	Total financial assets excl. pensions, households
Eq55	DLOG(PENSION_FUNDS_HI) = 4.596***- 0.49***LOG(PENSION_FUNDS_HI(-1)) + 0.47***LOG(EARNINGS_PRIV(-1)/LFSE_PRIV_EE(-1)) - 0.01***BR(-1) + 0.16***LOG(USA_SP500(-1)) - 0.018***D(LR) + 1.12***DLOG(FASN_HI), adj. $R^2 = 0.93$, sample: 1988-2017, Eq(4.2), p.171	Pension funds, households
Eq56	DLOG(FTSEX) = -0.05- 0.26***LOG(FTSE(-1)) + 0.086**LOG(USA_SP500(-1)) + 0.11***NUMLOANS(-1)/1000000 + 0.79***DLOG(USA_SP500) + 0.11*LOG(GOSN_COS(-1)) + 0.01D(USA_QE) - 0.91**DLOG(EARNINGS_PRIV_AWE) - 0.80*DLOG(LFSE_PRIV(-1)) - 0.15*DLOG(DOLLST) - 0.14***D83 - 0.14***D2003 + 0.12***D2006, adj. $R^2 = 0.90$, sample: 1978-2017 Eq(4.4), p.172	FTSE index
Eq57	FLSN_HI = - DEBT_HI	Total financial liabilities
Eq58	NFASN_HI=FASN_HI+FLSN_HI	Net financial assets
Eq59	DEBT_HI_LT=0.925*DEBT_HI_LT(-1)+(NUMLOANS*(HMEANADV/1000000))+LA_FC_MO_LT_ADD	Long-term debt liabilities, households
Eq60	DEBT_HI=DEBT_HI_LT+DEBT_HI_ST+DEBT_HI_OTHER	Total debt liabilities, households
Eq61	DEBT_HI_ST=0.12*YDN_HI(-1)	Short-term debt liabilities, households
Eq62	D(DEBT_HI_OTHER) = -381551.55***-0.44***DEBT_HI_OTHER(-1) + 0.14***GDPV(- 1) + 0.22***D(GDPV) + 6023.02***LR(-1) + 21.58***POPN65(-1) + 14248.86**D2002 + 20902.45***D2006 + 16193.93***D2011 + 17721.86***D2016 + 24623.70***D2017, adj. $R^2 = 0.85$, sample: 1988-2017, Eq(4.5), p.175	Other debt liabilities, households

No.	Equation in UKSIMM	Description
Eq63	DLOG(HPI)=1.34***-0.19***LOG(HPI(-1))+0.09**LOG(NUMLOANS(-1)/POPN(-1))+0.33**DLOG(EARNINGS_PRIV_AWE)-0.06*LOG(HB_HA(-1))-0.07*DLOG(STAMP_DUTY(-1)/(HP_MEAN(-1)*NUMLOANS(-1)))-0.03***LR(-1)-6.74*DLOG(HSTOCK_PR(-1))+0.0003**MIGW(-1)+0.097**D88, adj. $R^2 = 0.77$, sample: 1979-2017, eq(4.23), p. 193	House price index
Eq64	NUMLOANS = -7159466.09**+259.77***POPW(-1)-1715098.75***DEBT_HI_LT(-1)/YDN_HI(-1)-41804.897***LR(-1) - 62051.4***D(MORTGAGE_RATE) + 831740.21**DLOG(HPI(-1)/CP_M(-1)), adj. $R^2 = 0.75$, sample: 1979-2007, eq(4.24), p. 194	Number of mortgages
Eq65	HMEANADV=0.60*HP_MEAN*1000	Average mortgage advances
Eq66	HP_MEAN=HP_MEAN(-1)*HPI/HPI(-1)	Average house price
Eq67	HB_PR=160000	New house built, private sector
Eq68	HSTOCK_PR=0.35*POPN	Total housing stock
Eq69	STAMP_DUTY=55*HP_MEAN	Stamp duty
Eq70	HB_HA=0.5*POPN	House building, housing association
Eq71	SALESV=GDPV	Total sales, real
Eq72	SALESN=GDPN	Total sales, nominal
Eq73	ITN_PDTS=0.114*GDPN	Total taxes on products (VAT and others)
Eq74	SUBN_PDTS=0.005*GDPN	Total subsidies on products
Eq75	GVAN=GDPN-ITN_PDTS+SUBN_PDTS	GVA, nominal
Eq76	GVAN_NFCPC=0.595*GVAN	GVA, nominal, NFCPC
Eq77	GVAN_FC=0.073*GVAN	GVA, nominal, FC
Eq78	GVAN_COS=GVAN_NFCPC+GVAN_FC	GVA, nominal, corporate sector
Eq79	GOSN_FIRMS=GOSN_COS+GOSNMIX_HI	GVA, nominal, corporate sector and household firms
Eq80	GOSN_COS=GVAN-(ITN_PDTN-SUBN_PDTN)-(GOSNMIX_HI+GOSN_GG+COMPN_HI+(COMPN_W-COMPHN_W)+STN_INC)	Gross operating surplus, corporate sector
Eq81	COMPN_HI=1.23*(EARNINGS_PRIV)+COMPHN_GG	Total compensation to employees paid, households
Eq82	EARNINGS_PRIV=LFSE_PRIV*(EARNINGS_PRIV(-1)/LFSE_PRIV(-1))*(EARNINGS_PRIV_AWE/EARNINGS_PRIV_AWE(-1))	Private sector wages and salaries
Eq83	DLOG(EARNINGS_PRIV_AWE)=0.39-0.21***LOG(EARNINGS_PRIV_AWE(-1))+0.007*WAGE_TARGET+0.45***LOG((LFSE(-1))/POPN(-1))+0.10***LOG(GOSN_COS(-1)/CP_M(-1))-0.90**CUM_MIGW/POPW(-1)+0.03**DLOG(FTSE(-1)/CP_M(-1))-0.07DLOG(TU_MEMBERS_PRIVPC(-1))-0.04DLOG(HPI(-1))-0.02***D2000-0.04***D2009, adj. $R^2 = 0.95$, sample: 1988-2017, eq(4.25), p. 196	Private sector average weekly salary
Eq84	TU_MEMBERS_PRIVPC=TU_MEMBERS_PRIVPC(-1)	Union memberships
Eq85	WAGE_TARGET=@TREND	Wage target
Eq86	COMPHN_COS=GVAN_COS-GOSN_COS-ITN_PDTN+SUBN_PDTN	Total compensation to employees paid, corporate
Eq87	ITN_PDTN=ITN_PDTN_NFCPC+ITN_PDTN_FC+ITN_PDTN_HI	Other taxes on production
Eq88	SUBN_PDTN=SUBN_PDTN_NFCPC+SUBN_PDTN_FC+SUBN_PDTN_HI	Other subsidies on production
Eq89	TTAXN_COS=TTAXN_NFCPC+TTAXN_FC	Taxes on income and wealth, corporate
Eq90	LFSE=LFSE_PRIV+LFSE_GG	Total labour force
Eq91	D(LFSE_PRIV)=8948.14***-0.38***LFSE_PRIV(-1)+0.002**GDPV-0.00***KIVLV_COS_ONS(-1)+0.01***D(KIVLV_COS_ONS(-1))-173.73***BR(-1)+0.006***VAT_REGS(-1)-0.002**VAT_DEREGS(-1)-409.31***D2003+465.08***D2008, adj. $R^2 = 0.92$, sample: 1987-2017, eq(4.19), p. 188	Private sector labour force
Eq92	VAT_REGS=VAT_REGS(-1)	VAT registration
Eq93	VAT_DEREGS=VAT_DEREGS(-1)	VAT deregistration
Eq94	KIVLV_COS_ONS=1.01*GDPV	Total non-financial asset stock, real, corporate
Eq95	DLOG(LFSE_GGX)=0.38-0.45***LOG(LFSE_GG(-1))+0.36***LOG(CV_GG(-1))+0.57***DLOG(CV_GG)-0.24**DLOG(GDPV(-1))-0.10LOG(GDPV_PRIV(-1)/LFSE_PRIV(-1))-0.14***LOG(KIVLV_GG(-1)/LFSE_GG(-1))-0.04***D2012, adj. $R^2 = 0.86$, sample: 1989-2017	Government sector labour force
Eq96	LFSE_GG=LFSE_GGX	Government sector labour force
Eq97	KIVLV_GG=KIVLV_GG(-1)*0.97+DKV_GG	Total non-financial asset stock, real, government

No.	Equation in UKSIMM	Description
Eq98	POPW=POPW(-1)+MIGW	Working age population
Eq99	POPN=(1.59*1.0035^TRENDX)*POPW	Total population
Eq100	POPN65=POPN65(-1)*1.02	Population over 65
Eq101	CUM_MIGW=CUM_MIGW(-1)+MIGW	Total number of migrant workers
Eq102	MIGW=0.00012*GDPV	Incoming migrant workers
Eq103	EMP_RATE=LFSE/POPW	Employment rate
Eq104	LFSE_SE=0.1775*LFSE_PRIV	Self-employment in private sector
Eq105	LFSE_PRIV_EE=LFSE_PRIV-LFSE_SE	Employees in private sector
Eq106	D(LFSU)=1318.40***-0.198***LFSU(-1)-0.05***LFSE_PRIV(-1)-0.46***D(LFSE_PRIV)-0.80***D(LFSE_GG)+1.32***D(LFSE_65)+0.98***MIGW(-1)-44.13***D(BR)+23.88***@PC(CP_M)+156.62**D2010+9467.86MINIMUM_WAGE(-1)/EARNINGS_PRIV_AWE(-1), adj. $R^2 = 0.96$, sample: 1987-2017, eq(4.21), p.189	Unemployment
Eq107	ITN_PDTN_NFCPC=0.027*GVAN_NFCPC	Production taxes other than products, NFCPC
Eq108	SUBN_PDTN_NFCPC=0.0035*GVAN_NFCPC	Production subsidies other than products, NFCPC
Eq109	COMPHN_NFCPC=(COMPHN_NFCPC(-1)/EARNINGS_NFCPC(-1))*EARNINGS_NFCPC	Compensation to employees, paid, NFCPC
Eq110	EARNINGS_NFCPC=1.2*(EARNINGS_PRIV_AWE*55.5/1000)*LFSE_NFCPC, eq(4.26), p. 196	Wages and salaries, NFCPC
Eq111	LFSE_NFCPC=0.75*LFSE_PRIV_EE	Labour force, NFCPC
Eq112	GOSN_NFCPC=0.59*COMPHN_NFCPC	Gross operating surplus, NFCPC
Eq113	GVANX_NFCPC=COMPHN_NFCPC+GOSN_NFCPC+ITN_PDTN_NFCPC-SUBN_PDTN_NFCPC	GVA, nominal, NFCPC
Eq114	YPN_NFCPC=GOSN_NFCPC+0.035*FASN_NFCPC(-1)+0.042*FLSN_NFCPC(-1)	Gross primary incomes, NFCPC
Eq115	YDN_NFCPC=YPN_NFCPC+ECCN_NFCPC+OCTBN_NFCPC-TTAXN_NFCPC-SBFN_NFCPC	Gross disposable income, NFCPC
Eq116	SBFN_NFCPC=0.018*YPN_NFCPC	Social benefits, NFCPC
Eq117	OCTBN_NFCPC=OCTBN_NFCPC(-1)	Net current transfers, NFCPC
Eq118	TTAXN_NFCPC=0.0125*GOSN_NFCPC(-1)	Taxes on incomes and wealth, NFCPC
Eq119	ECCN_NFCPC=0.005*COMPHN_NFCPC(-1)	Social contribution, NFCPC
Eq120	FSN_NFCPC = SAVING_NFCPC + INV_GRANTS_NFCPC + OTH_CAP_TR_NET_NFCPC - DKN_NFCPC - DIN_NFCPC - DLN_NFCPC - DVN_NFCPC + BALANCE_NFCPC	Net lending position, NFCPC
Eq121	SAVING_NFCPC=YDN_NFCPC	Gross saving, NFCPC
Eq122	INV_GRANTS_NFCPC=0.045*GVAN_NFCPC(-1)	Investment grants, NFCPC
Eq123	OTH_CAP_TR_NET_NFCPC=100	Other capital transfers, payable, NFCPC
Eq124	DVN_NFCPC=0	Net acquisitions of valuables, NFCPC
Eq125	KIVLV_NFCPC_ONS=KIVLV_NFCPC_ONS(-1)*1.02	Stock non-financial assets, real, NFCPC
Eq126	KIVLN_NFCPC=KIVLV_NFCPC_ONS*(GDPP/100)	Stock non-financial assets, nominal, NFCPC
Eq127	DKV_NFCPC=D(KIVLV_NFCPC_ONS)+0.0875*KIVLV_NFCPC_ONS(-1)	Changes in non-financial asset, real, NFCPC
Eq128	DKN_NFCPC=DKV_NFCPC*(GDPP/100)	Changes in non-financial asset, nominal, NFCPC
Eq129	D(DIV_NFCPC)=32361.62***-0.613***DIV_NFCPC(-1)+0.15***D(GDPV_PRIV)-0.13***INVV_M(-1)-141480.86***DLOG(CP_M)-15936.26***D99+7941.02**D98, adj. $R^2 = 0.83$, sample: 1988-2017, eq(4.27), p.198	Changes in inventories, real, NFCPC
Eq130	DIN_NFCPC=DIV_NFCPC*(GDPP/100)	Changes in inventories, nominal, NFCPC
Eq131	DLN_NFCPC=0.0025*GVAN_NFCPC	Net acquisition of non-produced, non-financial assets, NFCPC
Eq132	FASN_NFCPC=FASN_NFCPC(-1)*GDPN/GDPN(-1)+FSN_NFCPC+0.25*LA_FC_MO_LT_ADD, Eq(4.6), p.176	Total financial assets, NFCPC

No.	Equation in UKSIMM	Description
Eq133	FLSN_NFCPC=-(DSL_NFCPC+LL_NFCPC+STL_NFCPC+DERL_NFCPC+IPL_NFCPC+OARL_NFCPC)	Total financial liabilities, NFCPC
Eq134	NFASN_NFCPC=FASN_NFCPC+FLSN_NFCPC	Net financial assets, NFCPC
Eq135	ITN_PDTN_FC=0.025*GVAN_FC	Taxes on production other than products, FC
Eq136	SUBN_PDTN_FC=0.0	Subsidies on production other than products, FC
Eq137	COMPHN_FC=1.25*EARNINGS_FC	Compensation to employees, paid, FC
Eq138	EARNINGS_FC=1.8*(EARNINGS_PRIV_AWE*55.5/1000)*LFSE_FC	Salaries and wages, FC
Eq139	LFSE_FC=0.05*LFSE_PRIV_EE	Labour force, FC
Eq140	GOSN_FC=0.87*COMPHN_FC	Gross operating surplus, FC
Eq141	GVANX_FC=COMPHN_FC+GOSN_FC+ITN_PDTN_FC-SUBN_PDTN_FC	GVA, nominal, FC
Eq142	YPN_FC=GOSN_FC+PICN_FC+PIDN_FC	Gross primary income, FC
Eq143	PICN_FC=0.013*FASN_FC(-1)	Property incomes received, FC
Eq144	PIDN_FC=0.014*FLSN_FC(-1)	Property incomes paid, FC
Eq145	YDN_FC=YPN_FC+SBFN_FC+ECCN_FC-TTAXN_FC+OCTBN_FC	Gross disposable income, FC
Eq146	OCTBN_FC=OCTBN_FC(-1)	Net current transfer, FC
Eq147	TTAXN_FC=0.26*GOSN_FC(-1)	Taxes on incomes and wealth, FC
Eq148	SBFN_FC=1.25*COMPHN_FC	Social benefits, FC
Eq149	ECCN_FC=2.0*COMPHN_FC	Social contribution, FC
Eq150	FSN_FC=SAVING_FC+INV_GRANTS_FC-TTAXN_FC+OTH_CAP_TRANS_FC-DKN_FC-DIN_FC-DLN_FC+BALANCE_FC	Net lending position, FC
Eq151	SAVING_FC=YDN_FC	Gross savings, FC
Eq152	INV_GRANTS_FC=0	Investment grants, FC
Eq153	OTH_CAP_TRANS_FC=100	Other capital transfers, payable, FC
Eq154	DLOG(DKV_FC) = 5.76***-0.57***LOG(DKV_FC(-1))-0.499***LOG(KIVLV_FC(-1)/(GVAN_FC(-1)/(GDPP(-1)/100))) + 6.62***DLOG(GDPV) + 0.097***LR(-1) - 0.04**TAX_CTRATE_BANKS(-1) - 0.61***D97, adj. $R^2 = 0.64$, sample: 1987-2017, eq(4.28), p.199	Gross fixed capital formation, FC
Eq155	KIVLV_FC=(1-0.06)*KIVLV_FC(-1)+DKV_FC	Stock non-financial asset, real, FC
Eq156	DKN_FC = DKN_COS-DKN_NFCPC	Changes in non-financial asset, nominal, FC
Eq157	DLN_FC=4	Net acquisition of non-produced, non-financial assets, FC
Eq158	FASN_FC=FASN_FC(-1)*GDPP/GDPP(-1)	Total financial assets, FC
Eq159	FLSN_FC=-FASN_FC	Total financial liabilities, FC
Eq160	NFASN_FC=FASN_FC+FLSN_FC	Net financial assets, FC
Eq161	ITN_PDTN_FC_MO=0.025*GVAN_FC_MO(-1)	Taxes on production other than products, FC_MO
Eq162	COMPHN_FC_MO=1.25*EARNINGS_FC_MO	Compensations to employees paid, FC_MO
Eq163	EARNINGS_FC_MO=2.33*(EARNINGS_PRIV_AWE*55.5/1000)*LFSE_FC_MO	Salaries and wages, FC_MO
Eq164	LFSE_FC_MO=0.0196*LFSE_PRIV_EE	Labour force, FC_MO
Eq165	GVAN_FC_MO=COMPHN_FC_MO+ITN_PDTN_FC_MO-SUBN_PDTN_FC_MO	GVA, nominal, FC_MO
Eq166	GOSN_FC_MO=155000+0.1*(((LR+0)/100)*FASN_FC_MO(-1)+((BR+0)/100)*FLSN_FC_MO(-1))-BAD_DEBTS	Gross operating surplus, FC_MO
Eq167	DLOG(BAD_DEBTS) = 60.14***-0.54***LOG(BAD_DEBTS(-1))-3.67***LOG(GDPV(-1))-0.26***BR(-1) - 28.00***DLOG(GDPV)-0.24***D(BR), adj. $R^2 = 0.78$, sample: 1989-2017, eq(4.29), p.201	Bad debts, FC_MO
Eq168	YPN_FC_MO=GOSN_FC_MO+0.015*(FASN_FC_MO(-1)-DERA_FC_MO(-1))+0.014*(FLSN_FC_MO(-1)+DERL_FC_MO(-1))	Gross primary income, FC_MO
Eq169	YDN_FC_MO=YPN_FC_MO+OCTBN_FC_MO-TTAXN_FC_MO, eq(4.30), p.201	Gross disposable income, FC_MO
Eq170	SAVING_FC_MO=YDN_FC_MO	Gross savings, FC_MO

No.	Equation in UKSIMM	Description
Eq171	OCTBN_FC_MO=OCTBN_FC_MO(-1)	Net capital transfers, FC_MO
Eq172	TTAXN_FC_MO=0.5*TAX_CTRATE_BANKS/100*GOSN_FC_MO(-1)	Taxes on income and wealth, FC_MO
Eq173	FSN_FC_MO=SAVING_FC_MO+OKTBN_FC_MO-DKN_FC_MO-DIN_FC_MO-DLN_FC_MO-DVN_FC_MO+BALANCE_FC_MO	Net lending position, FC_MO
Eq174	OTH_CAP_TRANS_FC_MO=100	Other capital transfers, FC_MO
Eq175	DKN_FC_MO=0.1*GVAN_FC_MO(-1)	Gross fixed capital formation, nominal, FC_MO
Eq176	FASN_FC_MO=FASN_FC_MO(-1)*GDPN/GDPN(-1)+LA_FC_MO_LT_ADD	Total financial assets, FC_MO
Eq177	FLSN_FC_MO=-FASN_FC_MO-LA_FC_MO_LT_ADD	Total financial liabilities, FC_MO
Eq178	NFASN_FC_MO=FASN_FC_MO+FLSN_FC_MO	Net financial assets, FC_MO
Eq179	FASN_FC_CB=FLSN_FC_CB*1.2	Total financial assets FC_CB
Eq180	FLSN_FC_CB=(M4L_FC_CB+DERL_FC_CB+ DSL_FC_CB+IPL_FC_CB+STL_FC_CB+LL_FC_CB+OARL_FC_CB)	Total financial liabilities
Eq181	NOTES_ISSUED=NOTES_ISSUED(-1)*GDPN/GDPN(-1)	Bank notes
Eq182	RESERVES=RESERVES(-1)	Bank reserves
Eq183	GVAN_HI=0.211*GVAN	GVA, nominal, households
Eq184	ITN_PDTN_HI=0.00165*GVAN_HI	Taxes on production other than products, households
Eq185	SUBN_PDTN_HI=0.0065*GVAN_HI	Subsidies on production other than products, households
Eq186	COMPHN_HI=1.23*EARNINGS_HI	Compensation to employees paid, households
Eq187	EARNINGS_HI=GVAN_HI*(EARNINGS_HI(-1)/GVAN_HI(-1))*1.02	Salaries and wage, households
Eq188	GOSNMIX_HI=GVAN_HI-ITN_PDTN_HI+SUBN_PDTN_HI-COMPHN_HI	Gross operating surplus and mixed incomes
Eq189	GOSN_HI=0.59*GOSNMIX_HI	Gross operating surplus, households
Eq190	LFSE_HI=0.2*LFSE_PRIV_EE+LFSE_SE	Labour force, households
Eq191	GVAN_GG=0.5*CN_GG+DKN_GG	GVA, nominal, government
Eq192	GOSN_GG=GVAN_GG-COMPHN_GG-ITN_PDTN_GG+SUBN_PDTN_GG	Gross operating surplus, government
Eq193	COMPHN_GG=LFSE_GG*0.9*(COMPHN_NFCPC/LFSE_NFCPC)	Compensation to employees paid, government
Eq194	YPN_GG=GOSN_GG+ITN_GG-SUBN_GG+0.032*FASN_GG(-1)+0.024*FLSN_GG, eq(4.32), p.204	Gross primary income, government
Eq195	ITN_GG=ITN_PDTS+ITN_PDTN-ITN_W	Taxes on products and production
Eq196	SUBN_GG=SUBN_PDTS+SUBN_PDTN-SUBN_W	Subsidies on products and production
Eq197	YDN_GG=YPN_GG+TTAXN_GG+ECCN_GG+OCTBN_GG-SBFN_GG-TAX_PAID_GG, eq(4.33), p.204	Gross disposable income, government
Eq198	SBFN_GG=19*(POPN65+LFSU)*(CP_M/100)	Social benefits, government
Eq199	TAX_PAID_GG=0.0065*GVAN_GG(-1)	Other current taxes, government
Eq200	OCTCN_GG=0.1*(CN_GG+DKN_GG)	Other current transfers, resource, government
Eq201	OCTDN_GG=0.1*(CN_GG+DKN_GG)	Other current transfers, uses, government
Eq202	OCTBN_GG=OCTCN_GG-OCTDN_GG	Net other current transfers, government
Eq203	TTAXN_GG=TTAXN_HI+TTAXN_COS-TTAXN_W	Taxes on incomes and wealth, government
Eq204	ECCN_GG=ECCN_NIC+ECCN_GG_PENSIONS	Social contributions, government
Eq205	DLOG(ECCN_NIC)=-1.57***-0.19**LOG(ECCN_NIC(-1))+0.34***LOG(EARNINGS_PRIV(-1))-0.18**LOG(NIC_UEL(-1))+1.06***DLOG(LFSE_PRIV)+0.031**D(NIC_MAIN)+1.81D(LFSE_SE(-1)/LFSE(-1))-0.097*DLOG(NIC_SE_MAIN_RATE(-1))-0.06***D2002+0.05**D2004, adj. $R^2 = 0.71$, sample: 1988-2017, eq(4.34), p.205	Compulsory social contribution, government

No.	Equation in UKSIMM	Description
Eq206	NIC_UEL=NIC_UEL(-1)*CP_M/CP_M(-1)	National insurance standard rate
Eq207	ECCN_GG_PENSIONS=0.165*COMPHN_GG	Social contributions, pension, government
Eq208	OTH_CAP_TRANS_GG=OKTBN_GG-TAX_CAPITAL_HI-INV_GRANTS_GG	Other capital transfers, government
Eq209	OKTBN_GG=-0.02*(CN_GG+DKN_GG)	Net capital transfers, government
Eq210	SAVING_GG=YDN_GG-CN_GG	Gross savings, government
Eq211	INV_GRANTS_GG=0.045*GVAN_GG(-1)	Investment grants, government
Eq212	FSN_GG=SAVING_GG+TAX_CAPITAL_HI+INV_GRANTS_GG+OTH_CAP_TRANS_GG-DKN_GG-DIN_GG-DLN_GG+BALANCE_GG	Net lending position, government
Eq213	DKV_GG=DKV_GG(-1)*1.03	Gross fixed capital formation, real, government
Eq214	DKN_GG=DKV_GG*(GDPP/100)	Gross fixed capital formation, nominal, government
Eq215	DIN_GG=DIV_GG*(GDPP/100)	Changes in inventories, nominal, government
Eq216	DLN_GG=-0.005*CN_GG	Net acquisition of non-produced non-financial assets, government
Eq217	FASN_GG=FASN_GG(-1)*GDPP/GDPP(-1)	Total financial asset, government
Eq218	FLSN_GG=-(DSL_GG+LL_GG+STL_GG+DERL_GG+IPL_GG+OARL_GG)	Total financial liabilities, government
Eq219	NFASN_GG=FASN_GG+FLSN_GG	Net financial assets, government
Eq220	NETDEBT_GG_ONS=NETDEBT_GG_ONS(-1)*FASN_GG/FASN_GG(-1)	Net government debt stock
Eq221	CBALN=(XN-MN)+(COMPN_W-COMPHN_W)+ITN_W-SUBN_W+SBFN_W+PICN_W+PIDN_W+(TTAXN_W_REC-TTAXN_W_PAID)+(OCTCN_W-OCTDN_W), eq(4.35), p.206	Current account balance
Eq222	COMPN_W=COMPN_W=0.00077*GDPN	Compensation to employees received, world
Eq223	COMPHN_W=COMPN_W=0.00067*GDPN	Compensation to employees paid, world
Eq224	ITN_W=0.00165*GDPN	Taxes on production and imports, world
Eq225	SUBN_W=0.00125*GDPN	Subsidies on production and imports, world
Eq226	SBFN_W=0.0014*GDPN	Social benefits, world
Eq227	PICN_W=0.018*FASN_W(-1)	Property incomes received, world
Eq228	PIDN_W=0.017*FLSN_W(-1)	Property incomes, paid, world
Eq229	TTAXN_W_REC=0.004*GDPN	Taxes on income, resource, world
Eq230	TTAXN_W_PAID=0.00025*GDPN	Taxes on income, uses, world
Eq231	TTAXN_W=TTAXN_W_REC-TTAXN_W_PAID	Net taxes on incomes
Eq232	OCTCN_W=0.018*GDPN	Other current transfers, resources, world
Eq233	OCTDN_W=0.009*GDPN	Other current transfers, uses, world
Eq234	FSN_W=CBALN+OKTCN_W-OKTDN_W+DLN_W+BALANCE_W	Net lending position, world
Eq235	OKTCN_W=0.001*GDPN	Capital transfers received, world
Eq236	OKTDN_W=0.0004*GDPN	Capital transfers paid, world
Eq237	NFASN_W=0-NFASN_HI-NFASN_GG-NFASN_NFCPC-NFASN_FC-(FASN_FC_CB-FLSN_FC_CB), Eq(4.7), p.180	Net financial assets, world
Eq238	FASN_W=-0.8*FLSN_W	Total financial assets, world
Eq239	FLSN_W=NFASN_W/0.2	Total financial liabilities, world

C. SFC matrices in ONS codes

Table C.1.: Transaction flow matrix, ONS codes

Blue book 2018 (data code)	**Households**		**Non-financial corporations**		**Financial institutions**	
Distribution and uses of income	Resources	Uses	Resources	Uses	Resources	Uses
B.1G Gross value added	QWLK		FAIS		NHDB	
D.1 Wages (D.1 incl employer social contributions)	QWLY	QWLP		FCFV		NHCR
D.2 Taxes on production and imports		QWLQ		EACJ		QYPT
D.3 Subsidies	QWLR		JQJV		NHCA	
D.4 All property income received	QWME	QWMI	FAKY	FBXK	NHDF	NHDI
D.5 Taxes		QWMS		FCBS		NHCP
D.61 Social contributions in kind (D.61) - pension contributions	L8RF	QWMY	L8TP		NQNZ	
D.62 Other social contributions (D.62)	QWML	QWMZ		L8TD		L8R3
D.7 Other transfers (D.7)	QWMO	QWNC	NRJB	FCBX	NQOE	NHDT
B.6g Disposable income	QWND		NRJD		NQOJ	
D.8 Pension fund equity changes	NSSE					NQOK
P.31 Individual consumption expenditure		NSSG				
B.8g Gross savings		NSSH		NRJD		NQOL
B.12 Current external balance						
Capital Account (Table 1.6)						
B.8g Gross savings	NSSH		NRJD		NQOL	
Capital transfers (Tables *.1.7)						
D.9 Net capital transfers	NSSN	NSSR	FCCQ	JRWJ	NHDZ	NHEC
Investment						
P.51c Consumption of fixed capital	QWLL	QWLL	DBGF	DBGF		NHCE
P.5 Total gross capital formation		NSSX		FCCZ		NHEG
Net non-financial assets	NSSY			FCFY	NHEI	
Changes in the year						
b.9n Net lending (+) / net borrowing (-)	NSSZ		EABO		NHCQ	
dB.9 Statistical discrepancy from BB	NZDV		NYPF		NYOX	
B.9f Net lending (+) / net borrowing (-)	NZDY		NYNT		NYNL	
Financial Account	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
F.1 Gold						
F.2 Currency and deposits	NFVS		NGII	A4VR	NFCU	NFFY
F.3 Securities	NFWB	NFZF	NGIR	NGLV	NFDD	NFGH
F.4 Loans	NFXD	NGAH	NGJT	NGMX	NFEF	NFHJ
F.5 Equities	NFXV		NGKL	NGNP	NFEX	NFIB
F.6 Insurance and pensions	NPWX	MA2Y	NGLE	NPXC	NPWR	NPWS
F.7 Derivatives	MN5V		MN5G	MN62	MN5J	MN65
F.8 Other accounts received	NFYP	NGBT	NGLF	NGOJ	NFFR	NFIV
FA/FL Total net acquisitions	NFVO	NFYS	NRGP	NRGR	NFCQ	NFFU
Balance sheet						
AN.2 Non-financial assets	NG4A		NG2I		NG38	
F.1 Gold						
F.2 Currency and deposits	NNMP		NNZF	NONX	NLJD	NLMH
F.3 Securities	NNMY	NNQC	NNZO	NOOG	NLJM	NLMQ
F.4 Loans	NNOA	NNRE	NOME	NOPI	NLKO	NLNS
F.5 Equities	NNOS		NOMW	NOQA	NLLG	NLOK
F.6 Insurance and pensions	NPYL	NPYM	NPYN	NPYO	NPYH	NPYI
F.7 Derivates	MMW5	MMY9	MMU6	MMX2	MMU9	MMX5
F.8 Other accounts received	NNPM	NNSQ	NONQ	NOQU	NLMA	NLPE
FA/FL Total assets/liabilities	NNML	NNPP	NNZB	NONT	NLIZ	NLMD

Table C.2.: Transaction flow matrix, ONS codes (continue)

Blue book 2018 (data code)	**Central Bank**		**General government**		**Rest of World**	
Distribution and uses of income	Resources	Uses	Resources	Uses	Resources	Uses
B.1G Gross value added			NMXN			
D.1 Wages (D.1 incl employer social contributions)				NMXS	KTMO	KTMN
D.2 Taxes on production and imports			NMYE		FJWB	
D.3 Subsidies				NMRL	FJWI	
D.4 All property income received						
D.5 Taxes			NMZL	EBFQ	FJWM	NHRS
D.61 Social contributions in kind (D.61) - pension contributions			NMZR			L8PV
D.62 Other social contributions (D.62)				NNAD	FJKO	
D.7 Other transfers (D.7)			NNAA	NNAN	FJWR	NHRW
B.6g Disposable income			NNAO		HBOG	
D.8 Pension fund equity changes			NMZT	NNAF		
P.31 Individual consumption expenditure				NMRK		
B.8g Gross savings				NNAU		
B.12 Current external balance					KTMY	HBOG
Capital Account (Table 1.6)						
B.8g Gross savings			NNAU		HBOG	
Capital transfers						
D.9 Net capital transfers			NNAY	NNBC	NHRZ	NHSC
Investment						
P.51c Consumption of fixed capital			NMXO	NMXO		
P.5 Total gross capital formation				NNBI		
Net non-financial assets				NNBJ		NHSG
Changes in the year						
b.9n Net lending (+) / net borrowing (-)			NNBK		NHRB	
dB.9 Statistical discrepancy from BB			NYOZ		NYPO	
B.9f Net lending (+) / net borrowing (-)			NYNO		NYOD	
Financial Account	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
F.1 Gold			NFPH	NFSN	NEWJ	M9MJ
F.2 Currency and deposits			NFPK	NFSO	NEWM	NEZQ
F.3 Securities			NFPT	NFSX	NEWV	NEZZ
F.4 Loans			NFQV	NFTZ	NEXX	NFBB
F.5 Equities			NFRN	No code	NEYP	NFBT
F.6 Insurance and pensions			NPWV	MA2W	NPWP	M9W4
F.7 Derivatives			MN5S	No code	MN5Y	MN6K
F.8 Other accounts received			NFSH	NFVL	NEZJ	NFCN
FA/FL Total net acquisitions			NFPG	NFSK	NEWI	NEZM
Balance sheet						
AN.2 Non-financial assets			NG3I			
F.1 Gold			NIFC	NLYW	M98E	M9ML
F.2 Currency and deposits			NLUT	NLYX	NLCV	NLFZ
F.3 Securities			NLWC	NLZG	NLDE	NLGI
F.4 Loans			NLXE	NNKW	NLEG	NLHK
F.5 Equities			NLXW		NLEY	NLIC
F.6 Insurance and pensions			NPYJ	NNBZ	NPYF	M9RN
F.7 Derivates			MMW2	MMY6	MMW8	MMZ4
F.8 Other accounts received			NLYQ	NNMI	NLFS	NLIW
FA/FL Total assets/liabilities			NPUP	NPVQ	NLEF	NLHJ

It should be noted that the UKSIMM is a simplified version of the national account matrices. For example, the financial account and the non-financial assets are not modelled.

Table C.3.: Blue book financial balance sheet data 2014 and 2015

(a) UKSIMM Financial balance sheet, 2014

2014	Households	Firms	Central Bank	Pension funds	Banks	Other financial institutions	Government	Rest of the world	Sum
Deposit net balance	1408071	536838	-335999	146465	-3150282	1050072	-56555	401390	0
Derivatives net balance	4003	-21507	-286	1881	4551	114997	972	-104611	0
Securities net balance	18645	-293277	389119	1067855	72108	-222415	-1692828	660793	0
Pensions net balance	3293088	-775076	115	-2450926	-41342	-29573	-17049	20763	0
Loans net balance	-1542859	-831251	9899	114565	3195336	-753215	118532	-311007	0
Equities net balance	887699	-1623739	0	1367423	59732	-640990	200532	-250657	0
Others net balance	118680	-59291	124	-71856	-2007	16780	-177	-2253	0
Net worth	-4187327	3067303	-62972	-175407	-138096	464344	1446573	-414418	0
Overall balance	0	0	0	0	0	0	0	0	0

(b) UKSIMM Financial balance sheet, 2015

2015	Households	Firms	Central Bank	Pension funds	Banks	Other financial institutions	Government	Rest of the world	Sum
Deposit net balance	1464552	578885	-335731	136653	-3091333	916820	-71888	402042	0
Derivatives net balance	4073	-24471	1205	1373	11034	25679	-143	-18750	0
Securities net balance	20570	-268143	389370	1073530	30263	-245823	-1696905	697138	0
Pensions net balance	3310130	-719379	332	-2521020	-37690	-28589	-25292	21508	0
Loans net balance	-1596861	-889099	11662	111908	3213260	-539156	111101	-422815	0
Equities net balance	923557	-1571673	0	1374316	22618	-650661	186770	-284927	0
Others net balance	104719	-66949	-3	-58518	-3217	28862	1538	-6432	0
Net worth	-4230740	2960829	-66835	-118242	-144935	492868	1494819	-387764	0
Overall balance	0	0	0	0	0	0	0	0	0